SCIENCE

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FRIDAY, SEPTEMBER 1, 1899.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE second half century in the history of the American Association was begun worthily last week at Columbus. It might have been feared that a meeting following the celebration of the fiftieth anniversary at Boston and held at some distance from the Atlantic seaboard would witness a small attendance and perhaps a lack of interest. This was by no means the case. The attendance was larger than at Detroit, Buffalo, Madison and Cleveland, and about the same as at Springfield, Indianapolis and Ann Arbor, while it was the unanimous opinion of those present that the meeting was in every respect profitable and enjoyable.

It seems evident that the Association has now entered upon a new era. In the course of fifty years the environment has altered greatly and for a little while there seemed to be some danger lest the Association might fail to adjust itself to the new condi-

tions. The missionary and social aspects of its work have become somewhat less important, while specialization in science seemed to give a heterogeneity that threatened to break up the parent Association into numerous special societies. But the Columbus meeting confronted any such theory with the unanswerable argument of success. The entertainment was admirably arranged so as to provide social intercourse without interfering with the scientific work of the sections, while in turn the meeting will assist the Ohio State University in the great career upon which it has entered. The affiliation of nine separate societies, either by amalgamation with the sections or by simultaneous meetings, proves that the specialization demanded by modern science may, in fact, contribute to the weight and authority of the Association representing science in America.

The organization of the Association and of the separate sections has in the past been somewhat amorphous. A council with no real powers, consisting chiefly of past Presidents usually absent and officers newly elected without special reference to their functions as councillors, could scarcely be expected to decide upon or to continue a definite policy. But at Boston amendments to the constitution were incorporated, giving the council authority to decide important questions and making it a truly representative and deliberative body. At Columbus further amendments were adopted assuring the presence of vice-presidents for two consecutive meetings and making them members of the council for three years. This action will also strengthen the sectional committees by giving them at least one member who has had some experience. We urge that Vice-Presidents should be members of the sectional committees for at least three years, as they now are of the council, and trust that an amendment to this effect may be introduced next year. On the other hand, it would probably be desirable for the secretaries of the sections to be members of the council only for the year in which they hold office.

The improvement in the deliberations of the council at Columbus was very evident. All business was transacted promptly, and wisely, without undue haste or undue delay. The council made the important decisions entrusted to it with a sense of its responsibility, and the amendments to the constitution recommended to the general session were adopted without dissent. The proposal to meet in New York next year was quite unexpected, it being supposed that either Denver or Philadelphia would be chosen. No formal invitations had been prepared, and it was expressly stated that the members from New York did not regard that city as a suitable place for public or private hospitality. A radical change in the time of the meeting was also proposed. Yet the council was able to consider these propositions on their merits and to come to a practically unanimous decision.

The wisdom of this decision cannot be questioned. After the meeting in Ohio precedent pointed to one of the great Eastern cities for the following year, where a large attendance could be expected. It is equally desirable to hold soon a meeting further towards the West than hitherto, and the recommendation to accept the cordial Denver invitation for 1901 sets a good pre-

cedent in designating a place for meeting well in advance. A week for the meeting immediately following the close of the colleges in June has much to recommend it. It does not break into summer expeditions, summer work and summer vacations as does a week in August, and the weather is likely to be favorable. New York City and the last week in June will be especially convenient next year for the large number of scientific men who at about that time will leave New York to attend the scientific congresses of the Paris Exposition.

The New York members do not propose to arrange for a welcome by the Mayor or his representative from Tammany Hall; they do not think that the Association can do much missionary work in the city or that the city can offer them entertainments and excursions, but they believe that they can make good arrangements for the scientific work of the sections and of the affiliated societies and can welcome the Association to a city that has made unusual scientific advances since the New York meeting of 1887. During these few years Columbia and New York have become great universities whose development is fittingly represented on new sites by magnificent libraries and laboratories; the American Museum of Natural History has perhaps quadrupled its buildings and collections; a museum of art and antiquities unsurpassed in America has been erected; a great public library has been founded and its building is in course of construction; an aquarium has been formed, and a botanical garden and a zoological park have been established that are preparing to rival the similar institutions of the great European cities.

Next year for the first time a place in the Association will be provided for students of physiology and experimental medicine, and for the first time the American Mathematical Society; the Society for the Promotion of Engineering Education and probably other societies will meet as part of the Association; the address of the retiring President will be made by a man honored and beloved of all; the meeting will be presided over by a leading man of science, whose services to the Association have been preëminent, and the arrangements will be made by a Permanent Secretary who has already proved his wisdom and ability. It is certain that there will be next year in New York an excellent meeting, and that it will be followed by a series of meetings that will make greatly for the advancement of science in America.

ADDRESS OF WELCOME.

DR. W. O. THOMPSON, President of the Ohio State University, said: It is a genuine pleasure to stand here this morning in the name of the Ohio State University, and extend a hearty welcome to the American Association for the Advancement of Science. We welcome you to our grounds, our buildings and our hearts. We pledge you now our utmost endeavor to make your stay as pleasant as we expect the meetings to be profitable.

There is no place on the continent where a company of men devoted to the study of science could be more welcome than at a State university. They are the peoples' institutions and have devoted their strength and energy to preparing young men and women for active participation in the rapidly growing civilization about us.

I need not remind you that the great Ordinance of 1787 was the beginning of public

education in the Northwest Territory. That ordinance provided for the support of education by generous grants of land. Out of this the public school system rapidly grew. The development of the public schools made possible the growth of the State university.

Nor need I remind you that the most characteristic feature of education in the last twenty-five years has been the growth and development of the State universities in this great territory. Nor need I remind you that to the west of us may be found a number of State universities older and better equipped and with a larger teaching force than the one with which you are now meeting. Ohio was the first State carved out of the Northwest Territory, but practically the last to develop her university.

To the west you may think of Indiana, Illinois, Michigan, Wisconsin, Minnesota, Nebraska, Kansas, Missouri, Colorado and others. You are meeting to-day at the gateway to these great educational centers. The Ohio State University is exceedingly happy in the privilege of extending a welcome to you, not only in her own name, but in the name of all these institutions which are to do so much in the future for industrial and scientific education in the Great West. We recognize in this Association a body of men devoted to the study of science and scientific education. We trust that your stay with us will assure you that the Ohio State University proposes to prove her right to existence by ministering to the needs of the people, and by presenting to them an open opportunity to the best that modern education can supply.

Let me assure you of a very cordial welcome and of our best wishes for a successful meeting.

ADDRESS OF THE PRESIDENT.

Dr. Edward Orton said: In behalf of the American Association for the Advancement of Science I return to you our cordial thanks for the welcome which you have this day given us to the capital of Ohio. We note with pleasure all that you say of the State and the City. We are sure that you have not exaggerated the charms of this noble section of the Mississippi Valley, which, all things considered, its location, its climate, its agricultural and its mineral resources, we take to be as the great Frenchman, De Tocqueville, declared, three-quarters of a century ago, the noblest dwelling place that God has fitted up for the occupation of the human race.

The principal office of such a reception as this is, I take it, to set both parties at their ease, to put host and guest on good terms with each other. You have spoken for the host and we accept all that you claim for the city and the State at its face value. We count ourselves happy to be here. We are glad to enjoy for a few days your hospitality. We hope and expect that the Columbus meeting of the Association will prove a memorable one, one that will shine in our annals, if not by the announcement of great discoveries in the heavens or earth, still by the inspiration it will give to multitudes of workers in the several fields of science.

And now let me say a word for the guests on this occasion. I shall ask you to accept, without any discount, all that we shall say about ourselves, all that we claim for our work, in the same generous spirit that we have already manifested toward you. People come to be on good terms with each other more easily, perhaps, if they are first on good terms with themselves. As our hosts you have shown a good measure of self-complacency, and you will not expect us to fall behind in this virtue. Well, then, I may say for the American Association for the Advancement of Science that it is well worthy of the hospitality which you proffer. It deserves all the honor that Columbus or any other community of the

country can pay it. No organization ever visits an American city that has a better claim on the appreciation and respect of all its people.

In the first place, you can hardly expect to entertain an organization of larger range, so far at least as its name is concerned. It is the American Association. It transcends not only all State limits, but national boundaries as well. An organization that represents the United States takes in a respectable part of the land areas of the planet, but this is not merely a United States organization. It especially includes that potent and ambitious neighbor of ours to the northward that owns more than three million square miles, or a full half, of the North American continent. The Association always counts with all confidence on its Canadian contingent. You can hear this afternoon an address from the honorable Canadian Vice-President of one of our sections, Mr. Whiteaves, of Ottawa.

Our name is broad enough to include also our neighbors to the southward, Mexico and the Central American republics, but these countries have thus far devoted so much of their time and force to military science in the practical way that they have not had much enthusiasm left for the cultivation of the other branches of science in which our Association is especially interested.

But there are American associations and American associations. They are not all alike. They are devoted to various interests. Some of them, in spite of the broad name they bear, have but a comparatively narrow field.

For example, there is an American Numismatic Society, an American Stock-breeders' Association, an American Strawboard Company, an American Detective Agency, etc., but this is the American Association for the Advancement of Science. As I have said, no organization can well have a broader geographical name, and when we come to its subject-matter, the field in which it works, certainly no organization can claim wider interest or greater importance.

The American Association for the Advancement of Science! Have you considered what this name implies? We are coming to the close of the nineteenth century, which has been well styled the century of science.

Alfred R. Wallace has recently published a careful inventory of the discoveries and inventions to which the progress of the race is mainly due, and he divides them into two groups, the first embracing all the epoch-making advances achieved by man previous to the present century, and the second taking in the discoveries and advances of equal value that have had their origin in the nineteenth century. In the first list he finds but fifteen items of the highest rank, and the claims of some even of this number to a separate place are not beyond question. They may not really be of epoch-making character. But he puts into the list the following, viz: Alphabetic writing and the Arabic notation, which have always been the two great engines of knowledge and discovery. Their inventors are unknown, lost in the dim twilight of pre-historic times. Coming after a vast interval to the fourteenth century A. D. we find the mariner's compass, and in the fifteenth the printing press, both of which, beyond question, are of the same character and rank as alphabetic writing. From the sixteenth century we get no physical invention or discovery, but it witnessed an amazing movement of the human mind, which in good time gave rise to the great catalogue of advances of the seventeenth century, the most prolific of all the centuries antecedent to our own. To it we credit the invention of the telescope and, though not of equal rank, the barometer and thermometer, and in still another field the invention of the

differential calculus, the all-important discovery of gravitation, of the laws of planetary motion, of the circulation of the blood, of the measurement of the velocity of light. To the eighteenth century we refer the more important of the earlier steps in the evolution of the steam engine and the foundation of both modern chemistry and electrical science. This completes the list. Counting all these inventions and discoveries as separate we get sixteen. Wallace places the barometer and thermometer under one number and thus makes a total of fifteen.

What is there to be added to this list? Some would urge that Jenner's discovery should be included here, but this claim Wallace would indignantly deny.

In making such a list it is evident that the personal equation of the author needs to be recognized, and different orders of arrangement, even if the elements were the same, would be assigned by different students. At any rate, something like this is the list of what the race has gained in science since it first came to itself, up to the year 1800. The greatest steps have certainly all been counted.

And now what has the record been since 1800? How does the 19th century compare with its predecessors? A brief examination will show that in scientific discovery and progress it is not to be compared with any single century, but rather with all past time. In fact, it far outweighs the entire progress of the race from the beginning up to 1800. Counting on the same basis as that which he had previously adopted, Wallace finds 24 discoveries and inventions of the first-class that have had their origin in the 19th century, against the 15 or 16, already enumerated of all past time. This is not a proper occasion to review, compare and set in order the several elements of this glorious list, but let me simply recall to your minds a few of them.

Of the same rank with Newton's theory of gravitation, which comes from the 17th century, stands out the doctrine of the correlation and conservation of forces of our own century, certainly one of the widest and most far-reaching generalizations that the mind of man has yet reached. Against Kepler's laws from the 17th century we can set the nebular theory of the 19th. The telescope of the 17th is overbalanced by the spectroscope of the 19th. If the first reveals to us myriads of suns, otherwise unseen, scattered through the illimitable fields of space, the second tells us what substances compose these suns and maintain their distant fires and, most wonderful of all, the state in which each exists, whether solid or gaseous, and the direction and the rate in which each is moving. Of the 56 stars whose motion in the line of sight have thus far been determined five were determined in the Emerson McMillin Observatory.

Harvey's immortal discovery of the 17th century finds a full equivalent in the germ theory of diseases of the 19th. The mariner's compass of the 14th century easily yields first place to the electric telegraph of the 19th, while the barometer and thermometer of the 17th century are certainly less wonderful, though, perhaps, not less serviceable, than the telephone and phonograph and Röntgen rays of our own day.

I need not pursue the comparison exhaustively, but, in addition to the advances now enumerated, the great doctrine of Organic Evolution, supported especially by the recapitulation theory in embryology, finds nothing to match with it in broadening and inspiring power, in all the past history of the race. The same can be said of the periodic law of Mendeljeff in chemistry, of the molecular theory of gases, of Lord Kelvin's vortex theory of matter, of the glacial period in geology, and of the establishment of the origin and antiquity of man, all of our own century.

Nothing can be brought from all the past

to compare for one moment in direct application to the relief of man's estate with the discovery of anæsthetics, while by his discovery of antiseptic surgery the name and fame of Lord Lister will grow to the last syllable of recorded time. In the mobilization of man and the giving to him the freedom of the globe, the railways and the steamships of our century are absolutely without any elements for comparison in all that the past has left us.

There are, however, three inventions and discoveries that have been inherited from the past and that have been already named, two of them from some distant but unrecorded centuries and one from the darkness of the Middle Ages, which have proved so indispensable to all subsequent advances that it is impossible for even the 19th century to present anything that can be properly compared with them. I refer to the alphabet, Arabic numerals and the printing press. To this list might perhaps be added language and the use of fire. The factors I have named are pre-supposed in all modern progress. By the very necessities of the case they must have preceded the progress at which we have glanced.

As I have before said, the 19th century is the century of science, and it is science, mainly physical science, that constitutes the proper object of this Association. Our geographical name is wide, but the scope of our Association is wider still. It deals with and is devoted to science, which is the product of the best powers of the human mind —the human mind, created in the image of God and divinely inspired to interpret this wonderful universe.

This Association marks the stage already reached in this interpretation, but in its very title it indicates that the work is incomplete, that it is still in progress. Its founders, fifty years ago, clearly saw that they were in the early morning of a growing day. The most unexpected and marvelous progress has been made since that date, but as yet there is no occasion and no prospect of modifying the title. We are still laboring for the advancement of science, for the discovery of new truth. The field, which is the world, was never so white unto the harvest as now, but it is still early morning on the dial of science.

It is possible that we could make ourselves more interesting to the general public if we occasionally foreswore our loyalty to our name and spent a portion of our time in re-stating established truths. Our contributions to the advancement of science are often fragmentary and devoid of special interest to the outside world. But every one of them has a place in the great temple of knowledge and the wise master builders, some of whom appear in every generation, will find them all and use them all at last,and then only will their true value come to light.

We do not always know the real significance of what we have in hand. A fact or an observation that we may put on record here may have in reality a different significance from what we are disposed to give it, and consequently may have far more importance than we recognize.

We welcome our hosts to our meetings and our discussions. We cannot promise that all will be found interesting, but occasionally conflicting views will give rise to animated debate in which human nature sometimes asserts itself so strongly and naturally that the debate would prove interesting to the outsider even though it may be carried on in what is practically a foreign tongue.

Thanking you again for your words of welcome and gratefully recognizing the arduous and efficient labors of the several committees of the gentlemen and ladies of Columbus in providing for our entertainment, I now declare the forty-eighth meeting of the American Association for the Advancement of Science open for the transaction of its appropriate business.

PROCEEDINGS OF THE ASSOCIATION.

THE forty-eighth annual meeting was held at Columbus, Ohio, from August 19th to 26th. There were 352 members and asciates in attendance and 273 papers were presented before the sections. Twenty-eight States, the District of Columbia and Canada were represented as follows: Ohio, 113; New York, 52: District of Columbia, 25; Pennsylvania, 21; Massachusetts, 18; Indiana and Michigan, 12 each; Iowa and Illinois, 9 each; Kentucky, 7; Canada, Connecticut, Kansas, New Hampshire, Nebraska and Wisconsin, 6 each; Minnesota, Texas and Maryland, 5 each; Missouri and Virginia, 4 each; West Virginia and North Carolina, 3 each; New Jersey and Colorado, 2 each; Alabama, Rhode Island, Washington and Louisiana, 1 each.

The papers were distributed among the sections as follows: Fourteen before Section 'A' (including five reports of progress); forty before Section 'B'; fifty-five before Section 'C'; fifteen before Section 'D'; thirty-three before Section 'E'; nineteen before Section 'F'; thirty-three before Section 'G'; twenty-seven before the Botanical Club of the Association; twenty before Section 'H,' and seventeen before Section 'I.'

The first general session was called to order at 10 o'clock on Monday morning by the retiring President, Professor Frederic W. Putnam, of Harvard University, who with a few remarks introduced the President-elect, Dr. Edward Orton, of Ohio State University. Dr. Orton took the chair and introduced General Axline, who welcomed the Association on behalf of the State of Ohio, and was followed by Judge M. B. Earnhart, representing the city of Columbus. Dr. William O. Thompson, President of the Ohio State University, then spoke on behalf of the University, and President Orton replied for the Association. The addresses of Dr. Thompson and of President Orton are given in full in this issue of SCIENCE.

A resolution by the Council was then read by the General Secretary, extending the privileges of associate membership to the members of the Local Committee, to citizens of Columbus and the immediate vicinity interested in scientific work, and to members of the affilliated societies meeting with the Association.

In accordance with custom the Permanent Secretary read the names of members and fellows of the Association deceased since the Boston meeting. Among these were the names of two honored past presidents of the Association, Professor O. C. Marsh, of Yale University, and Professor Daniel G. Brinton, of the University of Pennsylvania.

The Local Secretary, Professor B. F. Thomas, representing the Local Committee, then made announcement of the arrangements for the reception and entertainment of the Association. In addition to luncheons provided in one of the University buildings, the receptions given by President and Mrs. Thompson and by the Columbus Club, and the several entertainments provided for the ladies, the members of the Association were invited to join excursions to the gas fields near Lancaster, to the coal fields of the Hocking Valley, to the prehistoric fortifications at Fort Ancient, and to the islands in Lake Erie. The latter excursions were on Saturday and consequently did not interrupt the serious work of the sections. On Monday a more extended excursion was arranged to Mackinac and the Great Lakes. The excursions and entertainments were largely attended, and the resolutions of thanks presented by President Mendenhall at the close of the meeting were seconded and carried with unusual cordiality.

On Monday afternoon the addresses of the Vice-Presidents were delivered as follows:

At Two o'clock.

Vice-President BENJAMIN, before Section of Social and Economic Science. Subject: 'The Past Presidents of the Associations.'

Vice-President WHITEAVES, before Section of Geology and Geography. Subject: 'The Devonian in Canada.'

Vice-President THOMSON, before Section of Physics. Subject: 'The Field of Experimental Research.'

At Three o'clock.

Vice-President MACFARLANE, before Section of Mathematics and Astronomy. Subject: 'The Fundamental Principles of Algebra.'

Vice-President BULL, before Section of Mechanical Science and Engineering. Subject: 'Engineering Education as a Preliminary Training for Scientific Research Work.'

Vice-President GAGE, before Section of Zoology. Subject: 'The Importance and the Promise in the Study of the Domestic Animals.'

At Four o'clock.

Vice-President VENABLE, before Section of Chemistry. Subject: 'Definition of the Element.'

Vice-President BARNES, before Section of Botany. Subject: 'The Progress and Problems of Plant Physiology.'

Vice-President WILSON, before Section of Anthropology. Subject: 'Beginnings of the Science of Prehistoric Anthropology.'

These addresses are in course of publication in SCIENCE, while in the issue for last week will be found the address of the retiring President, Professor Putnam, on 'A Problem in American Anthropology,' delivered on Monday evening. On Wednesday evening Professor C. E. Munroe, of the Columbian University, gave the lecture complimentary to the citizens of Columbus, his subject being 'Applications of Modern Explosives.'

Among the items of executive business we may note that authority was given to officers of the Association whereby any section may arrange for a joint meeting with an independent society of similar scope. Section H was authorized to hold its usual winter meeting. The report of the Treasurer and Permanent Secretary showed a gratifying increase in the funds of the Association. In addition to income derived from investments, the Permanent Secretary was able to turn over to the Treasurer, to be added to the permanent fund, $1,000 derived from membership fees.

President Orton announced the gift of $1,000 from Mr. Emerson McMillin, well known for his generous benefactions to science. Thereupon Mr. McMillin was elected a patron of the Association.

The amendments to the constitution, acted upon by the Council and presented to the Association at the Boston meeting and already printed, were adopted. New amendments to the Constitution were proposed by Dr. McGee, making the term of office of the Treasurer five years and by Dr. Cattell adding a Section of Physiology and Experimental Medicine.

The Committee on the White Race in America made a report and was given a grant of $50 for the establishment of an anthropometric laboratory at the next meeting of the Association. A second grant of $50 was made for the quantitative study of biological variation under Dr. Davenport, and to report and extend this work a committee was appointed, consisting of Drs. Boas, Cattell, Minot, Eigenmann and Davenport. The only other grant made for research was one of $100 for the purpose of stocking pools with different species of blind vertebrates where they may be reared and studied in the light, the work being carried out by Professor Eigenmann.

Reports were also made by the committees on the library, on standards of measurement and on the U. S. Naval Observatory. Several committees that had accomplished the work for which they had been appointed were discharged.

The officers nominated for 1900 are as follows:

President—R. S. Woodward, Columbia University.

Vice-Presidents—Section A, mathematics and astronomy, Asaph Hall, Jr., University of Michigan;

section B, physics, Ernest Merritt, Cornell University; section C, chemistry, James Lewis Howe, Washington and Lee University; section D, mechanical science and engineering, J. A. Brashear, of Pittsburg, Pa.; section E, geology and geography, J. F. Kemp, Columbia University; section F, zoology, C. B. Davenport, Harvard University; section G, botany, W. Trelease, Missouri Botanical Garden; section H, anthropology, A. W. Butler, of Indianapolis; section I, economic science and statistics, C. M. Woodward, Washington University.

Permanent Secretary—L. O. Howard, United States Entomologist, of Washington.

General Secretary—Charles Baskerville, the University of North Carolina.

Secretary of the Council—William Hallock, Columbia University.

Secretaries of Sections—Section A, W. M. Strong, Yale University; section B, R. A. Fessenden, of Allegheny, Pa.; section C, A. A. Noyes, Massachusetts Institute of Technology; section D, W. T. Magruder, Ohio State University; section E, J. A. Holmes, University of North Carolina; section F, C. H. Eigenmann, University of Indiana; section G, D. T. Macdougal, New York Botanical Garden; section H, Frank Russell, Harvard University; section I, H. T. Newcombe, of Washington.

Treasurer—R. S. Woodward, Columbia University.

Frederick Bedell,
General Secretary.

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*THE DEFINITION OF THE ELEMENT.**

It is with hesitation that I enter upon so speculative a discussion as the nature of the elements, and yet there are reasons why it should prove of great profit to draw the attention of this representative gathering of the chemists of America to this subject. We have nearly reached the close of the first century in which these elements have been the subject of experimental research. The ingenuity and the patient labor of an army of workers have been directed at the solution of the many problems connected with these elementary substances, and the ultimate aim, the goal, of all their striving has been the discovery of the properties and the nature of the atom.

It is eminently fitting that, as we stand at the threshold of the new century, we glance back along the road we have already come and take some account of the progress we have made. The quicksands of mere speculation must be avoided, and yet the mental vision, the 'scientific imagination,' must be called into service in considering that which so far transcends our cruder actual vision as the incomparable atom itself. There is another reason for considering the nature of the elements. At several times during the century a wider vision has made it necessary to recast the definition of the elements to accord with increasing knowledge. It would seem as if another such period of change were approaching. There may be need of a truer definition, and how shall this be realized or the new definition properly fitted unless the knowledge gained be summed up and appreciated?

The conception of an element among the Greek philosophers and the earlier alchemists was very different from the modern idea. This conception sprang from the theories as to the formation of the material universe. The elements were the primal forms of matter seen only combined, impure, imperfect. They were the essences or principles out of which all things were evolved. In the four-element theory, which was so widely spread among the ancients, the fire, air, earth and water were not the ordinary substances known under these names, but the pure essences bestowing upon fire and water their peculiar properties. These essences were not thought of as actual substances capable of a separate material existence, and gradually the belief that a transmutation was possible between them sprang up. Thus they themselves might be derived from some one of

* Address of the Vice-President before Section C—Chemistry—of the American Association for the Advancement of Science, at the Columbus meeting, August, 1899.

them, as fire or water. The Thalesian theory deriving all things from water was especially popular and was not completely overthrown until the modern era.

When, later on, the alchemist conceived of all metals as composed of sulphur and mercury it was an essence or spirit of mercury that was meant. Certain common characteristics as luster, malleability, fusibility, combustibility, etc., naturally led them to think of the metals as belonging to the same order of substances containing the same principles, the relative proportions and purity of which determined the variations in the observed properties. Thus the properties of the metals depended upon the purity of the mercury and sulphur in them, the quantities of them and their degree of fixation. The more easily a metal was oxidized on being heated, the more sulphur it contained, and this sulphur also determined its changeability. The more malleable it was, the more mercury entered into its composition. If only something could be found which would remove the grossness from these essences, some unchanging, all-powerful essence, which, because of their search for it, gradually became known as the 'philosophers' stone,' then the baser metals might be transmuted into the noble gold when the sulphur and mercury were perfectly balanced and free from all distempers.

As has been said, these principles entering, all or some of them, into every known substance, were supposed to be not necessarily capable of individual existence themselves. This was the view held by the followers of Aristotle. With the reaction against the domination of the scholiasts, other views began to be held. It was Boyle who first gave voice to these changed views in his 'Sceptical Chemist' (1661). He defined elements as "certain primitive bodies, which, not being made of any other bodies, or of one another, are the ingredients of which all those called perfectly mixed bodies are immediately compounded, and into which they are ultimately resolved." He, however, did not believe himself warranted, from the knowledge then possessed, in claiming the positive existence of such elements.

But little attention was paid to the subject by the subsequent chemists. The phlogistics were too much occupied with their theory of combustion, and none could see the bearing of this question and its importance to exact science.

Macquer, in his 'Dictionary of Chemistry' (1777), words his definition as follows: "Those bodies are called elements which are so simple that they cannot by any known means be decomposed or even altered and which also enter as principles or constituent parts into the combination of other bodies." To this he adds: "The bodies in which this simplicity has been observed are fire, air and the purest earth." In all of this may be observed the resolution of observed forms of matter into primal principles following the dream of Lucretius and the early Epicurean philosophers, a dream abandoned by the atomic school following, though largely holding to the same definition.

It was only when chemists began to realize that mere observation of properties, chiefly physical, was not sufficient that the subject began to clear up and lose its vagueness. Black proved that certain substances were possessed of a constant and definite composition and fixed properties, unalterable and hence simple bodies or elements. Lavoisier finally cleared the way for the work of the nineteenth century by his definition that "an element is a substance from which no simpler body has yet been obtained; a body in which no change causes a diminution of weight. Every substance is to be regarded as an element until it is proved to be otherwise." With this clear

definition to build upon, a rational system of chemistry became, for the first time, a possibility.

Thus the elements were recognized as simple bodies because there were no simpler. They were not complex or compound. The distinction was clearly drawn between bodies simple and bodies compound, and the name simple body has been frequently used as a synonym for element through a large part of this century. Naturally the question of simplicity was first settled by an appeal to that great arbiter of chemical questions, the balance. And, quite as naturally, many blunders were made and the list of bodies erroneously supposed to be simple was very large. All whose weight could not be reduced were considered elementary. When, however, from such a body, something of lesser weight could be produced, its supposed simplicity was, of course, disproved.

This test for the elemental character has been clung to persistently, and is perhaps still taught, although it was long ago recognized that many of the elements existed in different forms, a phenomenon to which Berzelius gave the name *allotropism*. One only of these could be simplest, and the others could be reduced to this one and rendered specifically lighter. With the discovery of this relation it should have been quite apparent that the old definition would no longer hold good. But many years passed before chemists were made to feel that a new definition was necessary, and adapted one to the newer knowledge.

The insight into what Lucretius would call 'the nature of things' was becoming clearer; the mental grasp upon these elusive atoms about which the old Epicurean reasoned so shrewdly was becoming firmer. Through what one must regard as the veil interposed by the earlier idea of the element, the chemist began to grope after the constituent particle or atom. It must be borne in mind that the definition of the element was largely formulated before the resuscitation of the atomic theory by Dalton, and the mental picture of the one has perhaps retarded the clearing up of the ideas concerning the other. From the atomic point of view the element was next defined as one in which the molecules or divisible parts were made up of similar indivisible particles. This afforded an easy explanation of allotropism as a change in the number of atoms in a molecule. As Remsen says: "An element is a substance made up of atoms of the same kind; a compound is a substance made up of elements of unlike kind."

Laying aside, then, all vaguely formulated ideas of essences, or principles, or simple bodies, or elemental forms, we found our present building upon the conception of the ultimate particle, be this molecule or atom.

As to this atom some clear conception is needed, and here we come to the *crux* of the modern theories. The chemist regards this atom as a particle of matter and is unwilling to accept the theory of Boscovich that it is infinitely small, and hence a mathematical point, nor can he admit that it is merely a resisting point, and hence that all matter is but a system of forces. And yet it seems as though some authorities would lead up to such a conclusion.

While we need not consider these atoms as mere centers of forces, we are compelled to study them by the operation of forces upon them. What are called their properties have been studied and recorded with great care. These properties are evinced in the action of the forces upon matter, and the exhibition of force without matter cannot be admitted. This study of the properties has been the especial occupation of the century now closing, and so the elemental atom has come to be regarded as a collection of properties. As Patterson-Muir puts it (Alchemical Essence and the

Chemical Elements, p. 31): "The name copper is used to distinguish a certain group of properties, that we always find associated together, from other groups of associated properties, and if we do not find the group of properties connoted by the term copper we do not find copper."

These properties are exhibited by the action of a small group of forces. Perhaps we do not know all of the forces; certain it is that we do not accurately know all of the properties, but, to quote Patterson-Muir again: "The discovery of new properties always associated with a group of properties we call copper would not invalidate the statement that copper is always copper."

The properties of an atom are either primary, inherent and as unchanging as the atom itself, or they are secondary and dependent upon the influence of the other atoms, or varying with the change of conditions. To the first class belong such properties as the atomic weight, atomic heat, specific gravity, etc.; to the second, chemical affinity, valence, etc. In all the study of the atom the distinction between these should be carefully maintained in order that there may be clear thinking.

There is no field of mental activity requiring more faith than that of the chemist. He is dealing with the 'evidences of things unseen.' He must not be content with the mere gathering of facts, but divine what he can of their deeper meaning. Few chemists have had such insight as Graham into the significance of even the simplest changes. He was not content with mere surface observation. Even the commonest observed phenomena were to him full of meaning as to the atoms and their 'eternal motion.' Thorpe (Essays in Historical Chemistry, p. 219) has drawn afresh the attention of the chemists to the thoughtful words of this great thinker. His mind was filled with the fascinating dream of the unity of matter. "In all his work," says Adam Smith, "we find him steadily thinking on the ultimate composition of bodies. He searches after it in following the molecules of gases when diffusing; these he watches as they flow into a vacuum or into other gases, and observes carefully as they pass through tubes, noting the effect of weight, of composition, upon them in transpiration. He follows them as they enter into liquids and pass out, and as they are absorbed or dissolved by colloid bodies; he attentively inquires if they are absorbed by metals in a similar manner, and finds remotest analogies which, by their boldness, compel one to stop reading and to think if they really be possible."

In his paper entitled 'Speculative Ideas respecting the Constitution of Matter,' published in the Proceedings of the Royal Society in 1863, which Thorpe calls his 'Confession of Faith,' he tells of his conception that these supposed elements of ours may possess one and the same ultimate or atomic molecule existing in different conditions of movement.

It is not possible for me, in the limits of this address, to array before you all of the various evidence which leads to the belief that our so-called elementary atoms are after all but compounds of an intimate, peculiar nature whose dissociation we have as yet been unable to accomplish. When properly marshalled, it gives a very staggering blow to the old faith. Thorpe speaks of the "old metaphysical quibble concerning the divisibility or indivisibility of the atom." To Graham "the atom meant something which is not divided, not something which cannot be divided." The original indivisible atom may be something far down in the make-up of the molecule.

How shall the question as to the composite nature of the elements be approached? The problem has been attacked from the experimental side several times during the last half century, but the work

seems to have been carried on after a desultory fashion and was soon dropped, as if the workers were convinced of its uselessness. The results, being negative, simply serve to show that no method was hit upon for decomposing the elements upon which the experiments were performed. Thus, for instance, Despretz performed a number of experiments to combat Dumas' views as to the composite nature of the elements. Despretz made use of the well-known laboratory methods for the separation and purification of substances. Such were distillation, electrolysis, fractional precipitation, etc. Such work was quite inadequate to settle the question, as Dumas had pointed out that unusual methods must be used, or, he might have added, the old methods carried out to an unusual or exhaustive extent. Certainly, if a moderate application of the usual methods was sufficient for this decomposition, evidences of it would have been obtained long ago by the host of careful workers who have occupied themselves over these substances. Crookes has busied himself with the method of fractional precipitation (though not with special view to the testing of this question), and applied it most patiently and exhaustively to such substances as the rare earths, without obtaining results from which anything conclusive could be drawn. Victor Meyer seems to have believed that the decomposition could be effected by high temperatures, and was very hopeful of experiments which he had planned before his untimely death. Others have spasmodically given a little time to the problem, but no one has thought highly enough of it to attack it with all of his energy.

Let us stop a moment and ask ourselves what would be attained if any one should succeed in decomposing an element by one of the usual methods. Has not this been done repeatedly in the past and merely served to add to the list of the elements? Didymium has been made to yield praseo and neodymium. That which was first called yttrium has been divided into erbium, terbium and ytterbium, and according to Crookes may possibly be still further decomposed. But these and similar decompositions are not generally accepted as offering any evidence that elements can be decomposed. It is merely the discovery of one or more new substances which have remained hidden in constant association with known bodies which were supposed to be simple. It would be necessary to prove that a single individual element had, by the process adopted, been actually decomposed and not some pre-existing impurity discovered. This, of course, would be exceedingly difficult, and all such attempts as those mentioned can have little bearing upon the general question, and can hold out slight hope of reward beyond the fame springing from the discovery of a new element.

Successful decomposition should mean much more. It should mean the discovery of a method which will decompose not one, but many or indeed, all of the elements, and the decomposition of these must not yield a larger number of supposedly simple bodies, but a small group of one or two or three which are common constituents of all. It is quite idle to venture upon any prediction whether such a method will ever be discovered. Setting aside, then, the direct experimental proof of the composite nature of the elements as unattainable at present, let us next examine the indirect evidence. It would seem wisest for the present to introduce under that heading the spectroscopic work of Lockyer. The results, while highly interesting, are too indefinite as yet to speak of as having a direct bearing. Yet a careful study of the spectra of the elements leads us to a strong suspicion that the less plausible assumption is the one that the particles which give rise to such varied

vibrations are simple and unitary in nature. Lockyer's most recent work, following up the line of his 'Working Hypothesis' of twenty years ago, is very suggestive and may lead to important results (Chemistry of the Hottest Stars, Roy. Soc. Proc., LXI., 148; On the Order of Appearance of Chemical Substances at Different Temperatures, *Chem. News*, 79, 145). Still too much must be assumed yet for such work to be very conclusive. He writes of 'proto-magnesium and proto-calcium,' and Pickering discusses a 'new hydrogen,' all with an assurance and confidence which proves at least how deeply these changes in the spectra have impressed some of those who have most deeply studied them.

But a more important method of indirectly testing the question is through a comparison of the properties of the atoms. Such a comparison has been made as to the atomic weights. In other words, the idea of the composite nature of the elements followed very close upon the adoption of a stricter definition of them as simple bodies. Dalton, Prout, Döbereiner, Dumas, Cooke and many others have aided in developing the idea, sometimes faultily and harmfully, at other times helpfully. Some fell into the common error of going too far, but all were struck by the fact that when these combining numbers, or atomic weights, were compared strange and interesting symmetries appeared. The times were not ripe for an explanation of their meaning, and such crude assumptions as that of Prout, that the elements were composed of hydrogen, or that of Low, that they were made up of carbon and hydrogen, were too baseless to command much genuine support or to withstand much careful analysis. The important feature of agreement between such theories was the belief that the elements were composite and had one or more common constituents.

From the comparison of one property, the atomic weights, the next step was to the comparison of all the properties. This comparison is brought out clearest and best for us in the Periodic System. Here all the properties are very carefully tabulated for us. The study of the system leads indisputably to the conviction that this is not an arbitrary, but a natural arrangement, exceedingly simple in its groundwork, but embodying most fascinating symmetries, which hint of great underlying laws. He who looks upon it as a mere table of atomic weights has lost its meaning. It tells, with no uncertain note, of the kinship of the elements and leads to a search after the secret of this interdependence and of their common factor or factors. There is so much which is made clearer if we assume a composite nature for the elements that many do not hesitate to make the assumption.

Still another indirect method of approaching that problem is by analogy with bodies whose nature and composition are known. A very striking symmetry is observed between the hydrocarbons, and these in the form of compound radicals show a strong resemblance to certain of the elements. This analogy need not be dwelt upon here. It has been recognized for a long time and tables of hydrocarbons have been constructed after the manner of the Periodic System. Now these bodies are simply built up of carbon and hydrogen in varying proportions; and in any one homologous series the increments are regular. We know that they are composite and that they have but two common factors, carbon and hydrogen.

Again, the fact that certain groups of associated atoms behave as one element and closely resemble known elements may be taken as a clue to the nature of the elements. Thus carbon and nitrogen, in the form of cyanogen, behave very much like the halogens; and nitrogen and hydrogen in the form of ammonia so closely resemble the group of elements known as the alkalies

that this "volatile alkali" was classed with them before the era of our elements and the analogy lead to a vain search for an "alkalizing principle" and later to an equally futile pursuit of the metal ammonium.

A further clue to this nature is afforded in the remarkable changes of properties which can be brought about in some elements by ordinary means, and one might mention the equally remarkable veiling of properties induced by the combining of two or more atoms. Thus copper exists in a cuprous and a cupric condition, and the change from one to the other can be readily brought about. And this is true of many other elements.

This has doubtless been a tedious enumeration to you of well-known facts and arguments, but it has been necessary, for I wish to lead you to the summing-up of these arguments and to induce you to draw boldly the necessary deductions. It is high time for chemists to formulate their opinions in this matter. It would seem as if we were shut up to one or two conclusions. Either these imagined simple bodies are after all compounds, built up of two or more common constituents, or they are but varying forms of one and the same kind of matter subjected to different influences and conditions. The supposition that they are distinct and unrelated simple bodies is, of course, a third alternative, but to my mind this is no longer tenable.

The second hypothesis is the one put forth by Graham. It was his cherished vision of the gaseous particles about which he thought so deeply, and in many was so truly. Thorpe has written of this as follows (loc. cit. 222):

"He conceives that the various kinds of matter, now recognized as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. Graham traces the harmony of this hypothesis of the essential unity of matter with the equal action of gravity upon all bodies. He recognizes that the numerous and varying properties of the solid and liquid, no less than the few grand and simple features of the gas, may all be dependent upon atomic and molecular mobility. Let us imagine, he says, one kind of substance only to exist—ponderable matter; and, further, that matter is divisible into ultimate atoms, uniform in size and weight. We shall have one substance and a common atom. With the atom at rest the uniformity of matter would be perfect. But the atom possesses always more or less motion, due, it must be assumed, to a primordial impulse. This motion gives rise to volume. The more rapid the movement, the greater the space occupied by the atom, somewhat as the orbit of a planet widens with the degree of projectile velocity. Matter is thus made to differ only in being lighter or denser matter. The specific motion of an atom being inalienable, light matter is no longer convertible into heavy matter. In short, matter of different density forms different substances — different inconvertible elements, as they have been considered."

The hypothesis that the elements are built up of two or more common constituents has a larger number of supporters and would seem more plausible. Some have supposed one such primal element by the condensation or polymerization of which the others were formed. Thus we have the hydrogen theory of Prout, modified to the one-half atom by Dumas, and finally by Zängerle to the one-thousandth hydrogen atom. The suggestion of Crookes as to the genesis of the elements from the hypothetical protyle, under the influence of electricity, may also be mentioned here.

Others have adopted the supposition of two elements, Reynolds making one of these an element with a negative atomic

weight, whatever that may mean. Low and others have fixed upon carbon and hydrogen as the two elements.

There are many practical difficulties in the way of these suppositions; the lack of uniformity in the differences between the atomic weights, the sudden change of electro-chemical character, and the impossibility, so far, of discovering any law underlying the gradation in the properties of the elements with the increase of atomic weights, are some of the difficulties. In comparing these two hypotheses that of Graham seems to me very improbable. I have thought of valence as dependent upon the character of the motion of the atom, but cannot well conceive of a similar dependence of atomic weight and all the other properties. There remains, then, the hypothesis of primal elements by the combination of which our elements have been formed. These molecules are probably distinguished from the ordinary molecules by the actual contact and absolute union of the component atoms without the intervention of ether.

Since these elemental molecules cannot as yet be divided, we may retain the name atom for them, but the idea of simplicity and homogeneity no longer belongs to them. The definition of an element as a body made up of similar atoms is equally lacking in fidelity to latest thought and belief, but chemists would scarcely consent to change it, and, indeed, it may well be retained, provided the modified meaning is given to the word atom. But, after all, an element is best defined by means of its properties. It is by close study of these that we decide upon its elemental nature, and through them it is tested. Complete reliance can no longer be placed upon the balance and the supposed atomic weight.

All elements are acted upon by gravity and chemical force and other physical forces, but within the last few years certain gaseous elements have been discovered which are not influenced by chemical force or affinity. According to some (Piccini, *Zeits. An. Chem.*, XIX, 295) this necessitates a division of the elements into two classes. Manifestly, since it is chiefly by the action of chemical force that we study the elements, the absence of such action cuts us off from our chief means of finding out anything about them, and it is equally clear that bodies so diverse cannot well be classified together. If all attempts at bringing about the chemical union of these gaseous elements with other bodies fail, I believe that we should insist upon the existence of two classes of elements and keep them distinct in all comparisons.

Of course, we are quite at a loss to say just what chemical force is, but it is believed to be determined by the electrical condition of the atom. Thus we have the elements which show the action of chemical affinity varying from strongly electro-positive to strongly negative. This electrical charge of the atom seems to be a primitive, inherent property, and so beyond our control or power to change. At least no change of the kind has ever been recognized and recorded. Sodium remains positive and chlorine negative in spite of all that may be done to them. We can, by uniting the two temporarily, cloak and neutralize their opposite natures, but the original condition returns on their release.

Is it not fair to assume that argon, helium and their companion gases, having no affinity, are without electrical charge—atoms from which the electrical charge has been withdrawn; the deadest forms of inanimate matter? Were they thus without electro-chemical properties and affinity from the beginning, or did they start out as ordinary atoms (if I may so call them), and somehow, somewhere lose these properties, and with them the power of entering into union of any kind, even of forming

molecules, doomed to unending single existence? Can these be changed atoms of some of our well-known elements, a step nearer to the primal elements and with the electrical charge lost? Is it possible for us to bring about these changes? May we not unwittingly have done so at some time or other in the past? Is it possible to restore the electrical charge to such atoms, and so to place them once more on a footing of equality with elements of the conventional type? These and many other questions surge through the mind as one thinks of these wonderful gases. Perhaps the coming century will unfold the answers.

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*ENGINEERING EDUCATION AS A PRELIMINARY TRAINING FOR SCIENTIFIC RESEARCH WORK.**

At first thought it might seem that the subject chosen for this address is of such a nature that it should have been made the basis of a paper before the Society for the Promotion of Engineering Education. I admit that it would not have been out of place there, but at the same time I am of the opinion that such an address also forms, as it were, a bridge from our special engineering section to the purposes of the general Association. It will show that the work and the attainments of the engineer form an important and integral part of the scientific work of to-day.

As you no doubt know, there has been for some time general and strong misgivings as to the future of this section of the Association, and many have expressed the opinion that engineers and professors of engineering ought not to belong to the American Association for the Advancement of Science, as the work of the engineer and the pure scientist are of such a very different nature. It must, of course, be granted that the work of most practicing engineers is only distantly related to the work of the members of this Association belonging to the various sections, with the exception of D. But, on the other hand, a great many of the practicing engineers and of the professors of engineering do truly scientific work, and, what is more, in the opinion of the speaker, the preliminary training of the engineer is perhaps the best yet found to educate a man for future scientific research work.

These facts have led the speaker to believe that a consideration of the subject announced might perhaps increase the interest in Section D, and possibly thereby help to prevent its disappearance, which, to many of us, has seemed both imminent and deplorable.

Presumably our friends, the pure scientists, will shake their heads significantly when they read the title of this address, and if any of them should happen to hear it, or later read it, they might perhaps even go so far as to bestow a smile of pity on us poor engineers, etc., who have such a high opinion of our own worth. But even if none of our scientific brethren should be converted, the speaker would feel satisfied with the results should he succeed in giving more confidence to the members of the engineering profession in its broad sense as possessing the necessary training for accurate and important scientific research work.

The proposition which I expect to defend in this address is that engineering education as furnished in the best technical schools of the world, together with the training obtained later in life as a practicing engineer, probably furnishes the best preliminary preparation for the successful prosecution of scientific research work. I am now speaking of the preliminary training; the special knowledge of the subject in which the research work is to be done

* Address of the Vice-President before the Section of Mechanical Science and Engineering, American Association for the Advancement of Science, 1899.

must of necessity be acquired in addition to this engineering education, except when such work is in some one of the engineering branches. I desire also to call your attention to the fact that I do not mean to say that it is the only true method to gain the desired end, but that I have the feeling that, although all roads lead to Rome, yet this one is perhaps the most direct and possibly the best paved.

The object of scientific research work is, as I understand it, to ascertain the facts of nature, to correlate these facts, and finally to deduce the laws of nature as illustrated by the facts discovered. It is probable that a better definition might be given, but for the purpose of this address it is desirable that the various objects of scientific research work be given in something like the form above, and I feel very confident that the definition is one against which no serious objection can be raised. It will be noticed that I divide scientific research work into three parts, and I am sure that everybody will agree when I say that most of the scientific work done to-day is along the first line. The work of correlating the facts discovered is less common, and drawing conclusions from the facts thus correlated by establishing the laws of nature is of such a character that but few scientific workers get so far. That this is the case is but natural, because of the difficulties of the problem, and, although it is the most important of all scientific research work, yet, even of those who work in this special line, there are but few who are able to draw the correct conclusions, and this because of the lack of proper judgment in weighing the importance of supposed evidence and facts, or because of lack of previous training in suppressing the natural tendency to overestimate the value of one's own labor. I take it for granted that everybody appreciates the difficulties and failings which, because of the previous preparation, or, perhaps better, because of the lack of previous preparation, necessarily attach to the scientific research work of to-day. An inquiry into the necessary and desirable qualifications for a man working in this line will, I think, most rapidly lead us to the heart of the question raised in this address: Is not engineering education a remedy for a good many of the weaknesses found in the ordinary scientific man?

These qualifications will here be given separately as effecting the three kinds of work into which I have divided all scientific research work: First, what should be the previous training of a man who is to ascertain the facts of nature? He must necessarily have his faculties of observation trained to the highest degree, so that he sees the facts as they actually are, and, perhaps more important yet, that he can see the single fact which he is looking for, without being disturbed by surroundings which, in the eyes of the untrained man, would obscure the perhaps small objects for which the investigator is looking. It is also very necessary that the observer should be able accurately to describe the object, or fact seen. His mental habit should be such that accuracy is a necessity. And, finally, I think that the scientific worker should, for many kinds of observation, have his hands trained in such a manner that necessary apparatus can be used intelligently and even designed and made.

Second, what are the special qualifications for collecting and correlating the isolated facts of nature, as discovered by others? It seems to me that if anybody is to do this successfully he must possess all the qualifications of a worker in the first line, except that possibly he does not need the manual dexterity which is required by the original investigator. In order properly to classify the facts according to already existing rules and laws, he must also be familiar with the methods by which the

facts have been gathered, in order that he may be able to judge whether the results obtained by original investigators are really facts or only delusions. This man must, therefore, necessarily have a wider experience and outlook than the first observer, and he must possess a sharper judgment, which can only be obtained by special training.

Third, the scientific man who, from a large amount of material collected and correlated by others, shall be able to draw correct conclusions, so as to establish the laws of nature must necessarily have very special qualifications. He must not only have a wide outlook and a profound learning in his special branch; he must in addition be sober-minded, must be able to weigh evidence as thoroughly and impartially as the best qualified judge, and must not only see clearly, but be able to 'go behind the returns' so as to be in a position to decide whether the evidence presented is relevant to the case in question and if it be, whether it really represents facts. Having sifted the evidence, he must be capable of so surveying the field that the general law of which the isolated facts are exponents will reveal itself to his mind. For this latter purpose and to prevent visionary conclusions, I take it that a rigid training in accuracy and sobriety is required.

It is my contention that a man who has received a thorough engineering education, and perhaps has added a few years of professional work to scholastic training, is as well prepared to take up scientific research work as anyone coming from our universities and colleges. I do not think that anyone will deny that the work which is required of the engineering student in our best colleges tends very largely to establish a habit of accuracy, which, as was pointed out before, is one of the most essential qualifications of a scientific man. There is no study like mathematics, with its various applications, to teach a man accuracy; and, as this study forms the backbone in all engineering courses, it is only to be expected that the engineering student, when he leaves college, shall have acquired a habit of mind which makes it impossible for him to be inaccurate, either in his work or in his mode of expression. It is also my belief that the study of mathematics teaches truthfulness and sobriety of thought. As was explained before, the latter I deem one of the most essential qualifications for the man who is to do the highest grade of scientific work. Engineering education and the practice of the engineering profession will necessarily teach this sobriety of thinking more thoroughly than any other kind of education. The object of the engineering professions is to utilize the laws and forces of nature for the well-being of the human race. Consequently the engineer must build upon the laws of nature, must apply them, and the results of such application we see in the innumerable achievements of the engineer of modern times. The true engineer first surveys the field, then makes his plans and computations, based upon his observations and upon the laws of nature; the result of such work is, for instance, either the machine which is to do a certain work or the bridge which is to carry the modern heavy railway train, or it may be one of those monster buildings which within the last few years have been erected in the large cities. If the preliminary work of the engineer has not been accurate, or if he has not applied the laws of nature correctly, the result is inevitable; the machine will not do its work, the bridge will not carry the train, or the tall edifice building will not carry the enormous weight concentrated in it. The punishment will follow the mistake of the engineer as surely as the earth keeps on moving around the sun. This is the

great point in engineering education which, at any rate in some respects, makes it the best preliminary training for men who are to do scientific research work. A good engineer is necessarily an accurate man; he is necessarily also a soberly thinking man, and, thirdly, he must also possess a discriminating judgment, as the results which follow superficial reasoning or visionary planning are fatal to all engineering work. There are no studies which teach this lesson so strongly as the various professional engineering studies, and it seems to me, therefore, that one of the most essential qualifications for doing thorough scientific work is obtained in a higher degree by engineering education than by any other training. It is true that the ordinary engineering student has but limited opportunity to test his plans and computations in actual practice. But it must be remembered that the student is always reminded of the inevitable results of even one false step in the class-room, laboratory and draughting room, and that his work is controlled by men who are supposed to have had the necessary experience in practical life. That the actual practice of the engineering profession is the best teacher in this line need hardly be stated. The work of the engineering student in the draughting room, in the shop and in the laboratory fits him peculiarly for scientific research work, as he there gains the necessary dexterity of his hands, his powers of observation are being trained, and he learns to be accurate and neat. The only objection which perhaps might be raised against my contention is that the engineering courses of study are narrow in their nature, and consequently that the graduate of an engineering college will be a narrow man. It is true that in a certain sense the course of study is narrow; it does not include any classics, for instance; nor does it include as much of the humanities as is desirable. But, on the other hand, specialization has gone so far in the present day that I think I am correct when I state that, for instance, the ordinary classical course, with its excessive amount of Greek and Latin, is fully as narrow as the engineering course; and as to the scientific college course it is enough to say that there is no reason why it should be deemed less narrow than the engineering course, except for the fact that specialization has not been carried so far. The ideal engineering education is first an academic course, followed by two or three years' work in the engineering college, and if such length of time of study is not deemed too much for the profession of a lawyer there is no reason why it should be too long for the engineer. A man educated as just indicated would certainly be better fitted for scientific research work than any other college graduate who had an equal amount of time for preparation but had taken no engineering work.

That the engineer of the present day is doing a large amount of scientific research work does not need any proof, and because of his training I am of the opinion that his work is of a better quality than that of the ordinary scientific man; more reliance can be placed on it, as it necessarily has had to undergo a more severe test, both for accuracy and soundness in conclusion, than if it had been done by a person who had not had the preliminary training of an engineer.

To disprove this statement I suppose that some one might very likely mention the name of Kreidler, or perhaps even that of Kelley, but it is sufficient to state that these men are not, nor were they ever engineers, and it might also be pointed out that engineers are not responsible for any of the perpetual motions which, even in this enlightened day, seem to be as numerous as they ever were.

In conclusion, I desire to repeat that we engineers, or semi-engineers, need to feel

that our work is very often scientific research work of the highest character, and that although we are very often told that because of its practical nature it does not belong to pure science, yet we should insist that, whether it be pure science or not, it is scientific work, and because of our previous training is likely to be of permanent value.

I desire, finally, to offer an apology for the shortcomings probably altogether too visible in this address, and to express the hope that Section D of the American Association for the Advancement of Science, because of the large and important field which it represents, will start in on a new era of prosperity.

Storm Bull.

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FAUNA AND FLORA OF PUERTO RICO.

In the past the island of Puerto Rico was densely populated. Before Columbus discovered America and Ponce made his first European settlement on the island there had been two races on it, and each had occupied practically the whole of it. The first was, to judge by its shell heaps and other remains, a people of Northern origin, and the other was of the Carib race. At the time of the occupation by the Spanish the population was, according to their reports, as dense as it is now. It is now the most densely populated rural community proper on the continent of America. It has upwards of 230 inhabitants to the square mile, and this is strictly rural, as it has no great cities, the largest being of less than 40,000 inhabitants. The people generally live in the country, and the country huts are scattered in all sorts of places, expected and unexpected, from the crests of the mountains to the coasts.

Under these conditions only a very small original or wild fauna can be expected. Generally speaking, the largest wild mammal is a ground squirrel, about the size of a gopher. A few others of larger size are reported from time to time, but they are only occasional and are probably animals escaped from cultivation. Probably the larger animals once existed, and their traces could doubtless be found by a linguist in the place names which abound all over the island and are quite often not Spanish, but these creatures have been so long gone that they are not even mentioned by the natives, nor do the customary traditions otherwise refer to them.

The largest bird on land is the pretty white heron, of about the same size as the common heron of the Northern States. It belongs in the swamps. The nightingale is not rare, and sometimes in winter some of the Northern songbirds are seen, but in general the avian fauna is very sparse. The song and twitter of the birds is very rarely heard. Along the coasts the pelican, large and clumsy looking, except on the water, is very common where it is very much occupied with its profession of fisherman. It prefers protected harbors to the open water outside, and shows no greater shyness of man than to keep in the less disturbed waters of the ports.

The most common quadruped, by all odds, is the little lizard or swift, which can be seen almost anywhere in the sun and even frequently penetrates houses and lives with the family. They are very quick, intelligent, cleanly creatures and are only dangerous to cockroaches, flies and other small vermin. The largest land reptile is a snake, which sometimes reaches six or eight feet in length, something like the black snake, but called a python. It does no harm, so far as learned. There are a few other species of less size whose venom is not yet proved and is not feared by the natives.

The land crabs, snails and other such creatures are far from common, except in marshy places and near the coast. The

largest crab seen in some months' residence was a brilliantly colored pink and black one which belonged exclusively in the mangran swamps. Its very bright, clean coloring, its commonness there and its movements, characterized by a certain shifty handiness, make it a very striking object.

The greatest attraction of Puerto Rico for its tropical position is its relative freedom from insects, especially the noxious and troublesome ones. The scorpion and centipede are so rare that they are very seldom spoken of by the natives, and the so-called tarantula is only an overgrown spider, so far as learned not so large as that of New Mexico. The cockroach is common enough and sometimes reaches an enormous size before his fate overtakes him. Mosquitoes are generally not troublesome. Doubtless there are spots and seasons for an abundance of them, but these are not easy to find. The easterly breeze so common over the island and usually felt from afternoon to morning keeps these insects down.

The malignant germs of disease are not so much at home in Puerto Rico as in most other parts of the shores of the Caribbean. They can be introduced there and under favorable circumstances may have a considerable run—much as they would on the Gulf Coast of the States. The island is known as the healthiest of the Antilles and its winter season especially is most wholesome and charming.

The wild plant life has suffered equally with the wild fauna by the prolonged and all-pervading cultivation the island has received. Each part of the island not absolutely uncultivatable, even steep declivities, has been cultivated again and again, and even now slopes are carefully prepared for crops which are steeper than anything probably thus used in the States. They are so inclined that a loosened stone will roll down hundreds of feet and the cultivator hoes at nearly the level of his head.

The wild plants have little chance except on lands which for various reasons may have been neglected. In such places jungle and woods rapidly cover up the traces of cultivation and a few years change a field into a forest. There are many places that look like forests that are in a high state of cultivation, for many of the crops of Puerto Rico require shade when young and windbreaks when older. These crops may be grown in a natural forest from which all unnecessary trees and brush have been removed, or, more often, the man who owns the place makes a planted forest out of trees of certain species suited to protect the plants. Thus it happens that the island is much more generally forest-covered than its highly cultivated condition would indicate. Coffee is the crop most cultivated in this way.

The palms are few in kinds and in individuals. The commonest are the cocoa and the cabbage palm. The former loves the salt air from the ocean, but on this insular area it can be found at the greatest distance from the sea, here not more than twenty miles or so. The palm trees furnish thatch, standards, joists and siding for the native huts of the country, and the cabbage at the apex of the cabbage palm is used for food, though each cabbage costs a palm tree.

There are besides some scores of useful timber trees in the island, but they do not often occur in trunks large enough for the saw mill. The total number of such trees on the island must be considerable, but they are scattered, not in continuous forests, and are about as likely to be in villages as in the country. Besides, the wood is often too hard and the trunk too irregular and unsymmetrical for convenient use in the mill. The virgin forests are very few, perhaps none strictly virgin. There are in the mountains some areas that have the appearance of virgin forests, but they do

not have many large trees, and possibly do not date from many scores of years back. The Island of Culebra, a small island lying to the east of Puerto Rico and belonging to it, is said to be covered by virgin forests. There are several species of tree ferns on the island, always occurring at some distance back from the coast—and on the northern slope, so far as observed. They rarely surpass twenty feet in height.

Meadows have to be made, and for this a crab grass and a festuca or fescue-grass are used. The former is a good strong grass for the meadow and also makes an abundant, excellent, high-green hay. The hay could be imported into New York at a less cost than the inferior hay from up in the State, and could be brought into the market still fresh in the winter and early spring. The fescue is a better grazing grass and grows with great rapidity and to great height when it can support itself on shrubby vegetation. Cattle graze in it up to the brisket, and in protected places along the fences it is often seen from ten to fifteen feet high.

Mark W. Harrington.

THE BOTANICAL SOCIETY OF AMERICA.

The sessions of the 5th annual meeting of the Society were held on Friday and Saturday, August 18th and 19th, in Townshend Hall. The meeting was called to order by the retiring President, Dr. N. L. Britton, who then resigned the chair to the President-elect, Professor L. M. Underwood.

Officers elected for the ensuing year were :

President : Professor B. L. Robinson, Harvard University.

Vice-President : Professor B. D. Halsted, Rutgers College.

Secretary : Professor G. F. Atkinson, Cornell University.

Treasurer : Dr. Arthur Hollick, Columbia University.

Councillors : Professor D. P. Penhallow, McGill University, and B. T. Galloway, U. S. Dept. of Agriculture.

New members elected were :

Professor J. M. Macoun, Canadian Geological Survey.

Dr. W. J. Beal, Agricultural College of Michigan.

Dr. C. F. Millspaugh, Field Columbian Museum.

Dr. M. A. Howe, Columbia University.

On Friday evening the retiring President, Dr. N. L. Britton, delivered a public illustrated address in the chapel of University Hall, on : 'Report of Progress of the Development of the New York Botanical Garden.'

The following papers were read at the several sessions of the Society, in addition to which a number of others were read by title :

'Apetaly and Dioeciousness.' Professor C. E. Bessey, University of Nebraska.

'Symbiosis and Saprophytism.' Dr. D. T. MacDougal, New York Botanical Garden.

'The Effect of Centrifugal Force upon the Cell.' Professor D. M. Mottier, University of Indiana.

'The American Species of *Arisæma*.' Dr. N. L. Britton, New York Botanical Garden.

'The Classification of Botanical Publications.' Professor Wm. Trelease, Missouri Botanical Garden.

Arthur Hollick,
Secretary pro tem.

SCIENTIFIC BOOKS.

Naturalism and Agnosticism. The Gifford Lectures delivered before the University of Aberdeen in the years 1896–1898. By James Ward. Two volumes. The Macmillan Co. 1899.

The purpose of Ward's two volumes is not to defend scientific naturalism from the implication of agnosticism, but to show that the only way to escape from the 'determinism' of the naturalist is through philosophical idealism. The book is able and thoughtful and original, and one which all students of science would do well to study. For this reason I shall make no attempt to present a summary of its contents, although I shall try to call the attention of those who have read the book to a point of view which is very different from that of the author.

If one of the lessons of history is that dogmatism is the greatest foe of scientific progress, another lesson is that nothing has done more than reflection upon the meaning of nature to make natural knowledge definite and distinct, to strip it of all side-issues and irrelevant complications, and to put it into the form that commands assent; but the student must remember that the search for purpose in nature has been good for science only so far as it has been earnest and fearless, and, above all, single-minded; for very slight acquaintance with literature is enough to show that, among the motives of many writers upon natural theology, we often find evidence of a desire, conscious or unconscious, to find in nature support for some system of dogmatic theology rather than a basis for natural theology.

That the growth of natural knowledge has been uninterrupted and irresistible is due, in no small measure, to the desire which most of us feel to find out, if possible, what natural knowledge means. There are some, no doubt, who find in this the teleological argument, and see no reason for further search. If effort to find meaning in nature has clarified our concrete knowledge the advantage we have already found in natural knowledge may be its meaning.

Ward, as I understand him, does not share this opinion; for unless the meaning of knowledge is the advantage we are yet to find in it, as distinct from that which we have already found, he assumes that there can be no evidence of intention in nature, for he is one of those who hold, with Satan in the Book of Job, that no one can be expected to serve God for naught.

He tells us—II., 251—that, unless natural law is 'necessary,' the outlook is gloomy; for while the 'conception of Nature as a system of laws is hypothetical' the hypothesis is 'necessary' to our welfare, because 'knowledge of these laws is an indispensable means to that subjugation and control of nature upon which human welfare and advance in large measure depend.' The conception of nature as an ordered whole is therefore 'necessary,' since without it there could be no experience, and therefore no life, since 'experience is life.'—II., 231.

If I understand the naturalist and may be permitted to speak for him, he also holds the necessity of natural law to be necessary for our welfare as rational beings, although he is disposed to ask whether expediency may not be a better word than necessity. Food and drink are necessary to our welfare in this sense of the word, although it by no means follows that we are to have food and drink, for men have died of starvation, and we fail to find in nature any assurance that we may not all so die, for the fact that food and drink are necessary—that is, to be desired—is no evidence that we are to have them.

The naturalist agrees with Ward that our conception of the order of nature is not absolute, but contingent or relative, but he is not prepared to assert that it is a hypothesis; for a hypothesis is a mental product, and he does not know whether the contingency is mental or organic; whether—to use the language of the idealist—it is a sign, or the significance of a sign; whether it is a part of our actual experience or a part of that 'possible experience,' which, we are told, is necessary in order that there may be actual experience.

At any rate the naturalist is quite ready to admit that our conception of nature as rational order is a part of our constitution as rational beings. Using the language of his own little shop, he holds that it is a part of us, "as Nature has made us," although he admits that nature cannot 'make' anything, since nature is neither more nor less than that which is.

Ward tells us that the conception of natural law as necessary to our welfare is teleological, because our rational nature is due to the efficiency of a 'teleological factor,' or Lamarckian principle in the origin of species—Lecture X: that it is teleological because man has made himself, or, at the least, has had an efficient and intelligent part in making himself.

The naturalist, like the idealist, admits human agency, and tries to find out in what sense he is an agent, just as the idealist, while admitting a world of things, tries to find out in what its reality consists. To assert that man has made, or helped to make, himself is not to discover, but to assume, evidence of purpose in human nature. If such language is permissible it is hard to see why is is not also permissible to assert that nature has made men,

or even that "some of nature's journeymen had made men, and made them not well"; for the real question at issue, in each case, is how far the language is figurative.

The context seems to show that Ward does not hold his words to be figurative, for he asserts that not only man, but every living thing, has had an efficient and conscious part in its own production.

"Call an organism a machine, if you will," says he, "but where is the mind that made it, and, I may add, that works it?" And he answers this question by the statement—I., 294—that, while this mind is outside the dead machine, it is inside the living machine or organism and identical with it; for he contends that "mind is always implicated in life," or that, in other words, "a teleological factor, analogous to that of Lamarck, is operative and essential throughout all biological evolution." The context shows that it is not simply as part of an intended system of nature, but as an active agent of efficient cause, that each living thing is said to take part in its own production, although it is not easy to reconcile the statement—I., 294—that the mind of the living thing is inside it with the declaration—II., 127—that it is a 'metaphysical travesty' to assert that a mind can be inside a body. Clearly some of the author's language is figurative, and the reader must find out, as well as he can, what to take literally and what with a grain of salt. However, since "Natural selection works blindly upon promiscuous variation blindly produced," it is, of course, inadequate as a basis for Ward's idealism; although the assertion, in the next sentence, that it is immeterial for natural selection how variations are produced, seems to show that it may be the eye-sight of the process and not that of the product which is defective, if one is able to find any meaning in the statement that a process is blind.

While admitting the existence of the selective process, Ward fails to find in it any efficiency, causality or agency, and the naturalist is more than ready to agree with him, for to him also selection is only a statement of fact and not an efficient cause. He, therefore, fails to see how it can be either blind or possessed of eye-sight. Ward, finding natural selection blind, believes that he finds for it a *πoῦ στῶ* in the Lamarckian principle that "the production of a new organ in an animal body (or in a living body) results from a new want arising and continuing to be felt, and from the new movement which this want initiates and sustains," while the naturalist, if he be also a teleologist, finds the *πoῦ στῶ* in his conviction that it is good to have lived.

Ward, admitting selection but finding it blind, believes that its raw material must be supplied by a 'teleological factor' before it can 'do' anything. He, therefore, asserts that both a non-teleological factor—*natural selection*—and a teleological factor are concerned in the origin of species. He admits that the "complete unravelling of the two sets of factors, teleological and non-teleological, so as clearly to exhibit their respective shares in any given form is probably an impossible task," although we must ask, in this case, how he knows that there are two. "Not a few temples to the Deity founded on some impressive fact supposed to be safely beyond the reach of scientific explanation have," he reminds us, "been overtaken and secularized by the unexpected extension of natural knowledge."

He says that if we understand mind as always implicated in life and operative and essential throughout all biological evolution "we come upon two principles that lead us straight to the teleological factors of organic evolution." One of these is the principle of self conservation; the other is the principle of subjective or hedonic selection. "These principles furnish natural selection with the *πoῦ ὅτῶ* it seems to demand."

"By the principle of subjective selection special environments are singled out from the general environment common to all." "Take the passengers on a coach going through some glen here in Scotland; in one sense the glen is the same for them all, their common environment for the time being. But one, an artist, will single out subjects to sketch; another, an angler, will see likely pools for fish; the third, a geologist, will detect raised beaches, glacial striation, or perched blocks. Turn a miscellaneous lot of birds into the garden; a fly-catcher will at once be intent on the gnats, a bulfinch on the pease, a thrush on the worms and snails. Scatter a mixture of seeds evenly over a diversi-

fied piece of country; heath and cistus will spring up in the dry, flags and rushes in the marshy, ground. * * * Two artists or two anglers may be in each other's way, but an artist and an angler will hardly incommode each other. A garden would still interest a fly-catcher if there were neither pease nor cherries in it, provided the insects remained. Natural selection, as distinct from subjective selection, comes into play only when two anglers contend for the same fish, two artists compete for the same prizes; when the early bird gets the worm that the later one must go without."

So far all seems clear, except that the seeds that fall by the wayside do not seem to have much opportunity to escape from natural selection, or to exercise their teleological factors, although Ward fails to tell us what will happen if the would-be artist has mistaken his vocation, or if the family of the fisherman are suffering because of his absence while he is looking for likely pools. As for the geologist, who seems to have dropped out of sight, he is an illustration of natural selection, for, as Berkeley has pointed out, "the work of science is to unravel our prejudices and mistakes, untwisting the closest connections, distinguishing things that are different, instead of confused and perplexed giving us distinct views; gradually correcting our judgment and reducing it to a philosophical exactness." The correction of our natural responses and their reduction to a philosophical exactness by the suppression of those that are confused and perplexed and the preservation of those that are definite and exact, and, ultimately, by the extinction of the deluded minds and the survival of those that are sane, is what the naturalist means by natural selection.

When we consider how marvellous are the activities of a living organism, and how far the wisest man is from perfect knowledge of even the simplest organic mechanism, it is clear that we cannot hope for much from its attempts to give intelligent help in its own production; and Ward tells us that the condition of progress "seems provided, without any need for a clear prevision of ends or any feeling after improvement or perfection as such, simply by the waning of familiar pleasures and by the zest of novelty. In the midst of plenty it is usual to become dainty and to make efforts to secure better fare, even though the old can be had without them."

"Thus—even if there were no natural selection of variations fortuitously occurring, and even if there were no struggle for subsistence, still—the will to live, the spontaneous restriction of each individual to so much of the common environment as evokes reaction by its hedonic effects (with the increasing adaptation and adjustment that will thus ensue) and, finally, the pursuit of betterment to which satiety urges and novelty prompts—these conditions, really implying no more than the most rudimentary facts of mind, will account for definite variations to an apparently unlimited extent. What is more, the variations so produced, even if there were no others, would furnish natural selection with an ample basis as soon as struggle for existence began."

Thus we find that, even if there were no natural selection, the principle of self-conservation, and the principle of the zest of novelty—selfishness and want of steadfastness—are enough to bring about exquisite adjustment of each living thing to its environment. To this, exhaustive analysis of Ward's two volumes brings us down, and from this, he assures us, a rational synthesis builds up the philosophy of idealism; for nothing is easier than for one who is not a naturalist to improve upon the work of Charles Darwin.

The naturalist may be disposed to ask, however, whether unselfish interest in the welfare of the race and of posterity may not be at least as important in the history of organic evolution as 'the teleological principle of self-conservation.' Inasmuch as innumerable species have been exterminated for each one which now survives, and inasmuch as it can be proved that the genetic lines of most of the living organisms that now exist are destined to rapid extinction, it is clear that, as a matter of fact, most living things that have had a part in the selection of their environment have made more or less of a mess of it; for no one except a philosopher can lose sight of the truth that aptitude for experience is not, unfortunately, the same as aptitude for beneficial experience. It is at most no harder to acquire pernicious experience than to acquire

beneficial experience; no harder to cultivate bodily infirmity, or logical inconsequence, or mental imbecility, or moral obliquity, than to make the best of our faculties and opportunities.

The naturalist must also ask whether the contented enjoyment of normal life may not afford better evidence of intention than fickle lack of stability.

Those who are satisfied with the sort of natural theology which finds its type in filial affection, based upon gratitude rather than expectations, may possibly find evidence for this sort of teleology in nature, without first settling the disputes of the philosophers about the relation between mind and matter.

The most obvious answer to reasoning like Ward's is that we fail to find in nature any reason why all life, or, for that matter, all nature, may not come to an end this instant; for the assertion that the stability of nature is necessary to our welfare means nothing more than that this stability is much desired by those who have found life worth living.

If we are sure only of the present and of the past, and if science gives us nothing more than reasonable expectations about the future, which may or may not prove well founded, it is evident that we must look to the present and to the past for evidence of purpose in nature if we are to find it in nature at all.

They who are dissatisfied with this sort of purpose, and tell us it weighs upon them like a nightmare, must remember that there is no reason to doubt and good reason—as good reason as our own existence—to expect that the future will, on the whole, be essentially like the past; and that while the so-called predictions of science are no more than reasonable expectations they are reasonable expectations, since they are part of our nature as reasonable beings, as we have come about in accordance with the mechanical principle of natural selection.

If I am sure that natural knowledge has been useful and profitable and delightful to me I am as utterly unable to see why the discovery of a mechanical equivalent for truth should affect this conviction as I am to see how the scientific study of the mechanism of digestion can destroy my conviction that food and drink have, on the whole, been good for me: as unable as I am to see here proof that I do nothing which one who had exhaustive knowledge of any organic mechanism might have expected one to do, would prove that I am not reasonable and responsible. It is true that I have suffered because of my food, but I have never suffered from natural knowledge, and better knowledge of the mechanism of digestion might have helped me to avoid this suffering.

So far as I understand the scientific frame of mind, and may be permitted to speak for the naturalist, he is neither a materialist nor an idealist nor an agnostic monist, although the 'possible experience' of the idealist seems to him to afford ample room for a physical universe as material as the most ardent materialist could desire. It also seems to him that if common folks are to refrain from a search for purpose in nature until the philosophers have settled all their little questions and have reached an agreement among themselves they had better abandon all hope of finding the meaning of nature.

Each new philosopher assures us that his only motive is to help us to reach the truth and to set our minds at rest, but it may be that while philosophers fall out the simple-minded men of science may come by their own and live at ease.

W. K. Brooks.

Johns Hopkins University.

The Races of Europe. William Z. Ripley. New York, D. Appleton & Co. 1899. Pp. xxxii+624. Accompanied by a Supplementary Bibliography of the Anthropology and Ethnology of Europe, published by the Public Library of the City of Boston. Pp. x+160.

The interesting series of articles on the physical anthropology of Europe which Professor Ripley contributes to *Appletons' Popular Science Monthly* has been published in a revised form under the above title, accompanied by a very full bibliography of the subject. The work is based on a study of the very extensive published and much unpublished material that has been collected in various parts of Europe, and is an attempt at coordinating the results obtained by European investigators. The labor and the difficulties involved in a task of this kind are formidable, and the author deserves the thanks of all students for having made

easily accessible a vast amount of scattered literature. He has set forth, with great clearness and in a most fascinating form, certain results obtained by detailed statistical inquiries of great magnitude. The graphical coordination has been made with admirable skill, which will appeal to every one who knows the difficulty involved in combining material collected according to different methods and under different conditions. For this reason the useful and highly instructive maps of a large portion of Europe, and even of the whole globe, must be taken for what they are intended—as graphic representations of the known features of various human types so far as known at the present time, but without any claim to absolute accuracy, which in the present state of our knowledge would be impossible. The material comprised in these maps enables the author to present concisely and clearly a number of the most important problems of European somatology.

The primary object of Professor Ripley's studies is the explanation of the present distribution of human types in Europe. Four factors determine the same: heredity, environment, chance variation and selection.

It is a difficult task to ascribe to each of these its proper sphere of influence in the development of the human types inhabiting a continent whose people have undergone so many changes of location as those of Europe. Professor Ripley agrees with most authors in recognizing three fundamental types in Europe: the long-headed, dark Mediterranean; the short-headed, brunet Alpine; and the long-headed, blond Teutonic type. The author rightly dwells on the fact that, on the whole, human types are comparatively stable in given areas, and for this reason prefers to give to the types geographical names (p. 128). He suggests that it would have been desirable to designate the type of northwestern Europe also by a geographical term—such as Deniker's 'Nordic'—rather than by a national term, such as 'Teutonic,' which he uses throughout. The prevalent types of various regions he explains largely as due to mixtures of these fundamental types, and as modifications due to environment, chance variation and selection.

The multiplicity of these causes and our lack of knowledge of the mode of their action make all conclusions based on them very doubtful. The causes may be combined in various manners to explain a given phenomenon. The lower stature of mountaineers is explained by less favorable economic conditions, while the still less favorable influence of the highest region is said to be counterbalanced by its selective influence, which eliminates the less vigorous elements of the population. When the obscure effects of social or geographical environment are insufficient to explain existing conditions, heredity as expressed by mixture, and selection or chance variation, enter as convenient factors which enable us to find a plausible explanation. The ease with which the extremely complex phenomena can be explained by various combinations of these causes seems to me a reason of weakness of the conclusions set forth by Professor Ripley. Our ignorance of the conditions which influence modification of inherited form suggest that before accepting a given theory we should seek for historical corroboration of the same. This has been given in a few cases, as in the discussion of the types of Britanny (p. 101); but sufficient historical and archæological evidence is not available or has not been given to raise many conclusions beyond serious doubt. It would seem that combinations of causes such as are brought forward to explain the conditions in Burgundy (p. 144) are so uncertain that they cannot be considered more than a very risky hypothesis. The uncertainty of this method is also well illustrated in the discussion of the characteristics of the types of the Alps. The author is led to explain in many places the permanance of the Alpine types by the remoteness and unattractiveness of Alpine valleys, while in others the high variability of the Alpine population is explained by the assumption that the valleys contain the 'ethnological sweepings of the plains' (p. 106). Historical evidence is just as much necessary in the study of physical types as it is in that of geographical names, which are very liable to lead to erroneous results, unless studied in their oldest accessible forms. Only when our knowledge of the causes influencing human types is much more definite than it is now may we hope to reconstruct the de-

tails of their history without the corroboration of historical evidence. Many of the explanations contained in the book are certainly plausible, and add very much to its attractiveness; but I should be inclined to emphasize the elements of uncertainty much more than the author does.

On the whole, Professor Ripley considers economic attractiveness as one of the principal causes that regulate the distribution of types. According to his theory the fertile plains were always subject to foreign invasion, while the less fertile hills contain the most ancient types. While in historic times, when population had reached a considerable density, this cause must have been very effective, we may doubt if it acted in the same manner in very early times, when the continent was sparsely settled, when agriculture was not the only means of subsistence and when dense forests and swamps, difficult of access, or steppes that are now fertile occupied plains. The author calls attention to the fact that the invasion of the Alpine type cannot be explained in this manner.

I feel least in accord with Professor Ripley's ready resort to mixture as an explanation of peculiarities of type. This view is closely connected with the interpretation of what constitutes a type or a race. I do not think the term 'Races of Europe' a fortunate one, but, with Gerland and Ehrenreich, I am inclined to reserve the term for the largest divisions of mankind. The differences between the three European types are certainly not equal in value to the differences between Europeans, Africans and Mongols; but they are subordinate to these. The term 'type' appears most appropriate for the sub-divisions of each race.

It would seem that if the author had given us in his work not only an analysis of what differentiates the various types of Europe, but also a description of what is common to them —a subject that would seem eminently proper in a discussion of European man—his views might have been somewhat modified. The important anatomical characteristics of the race as a whole have found no place in his work; in the chapter on European origins (pp. 457 ff), in which he deals with the general question of race, only the anthropometric evidence and pigmentation are treated. Considering the most generalized form of the European race as it reveals itself in the child, we should be inclined to consider it a highly specialized form of the Mongoloïd, type from which it departs principally by the peculiar development of the nose and adjoining parts of the face and by a general decrease of pigmentation. On account of the high degree of variability; of the originally small distribution of this type, and of the apparent tendency of hybrids with other races to revert to the other parental race rather than to the European Race, I should be inclined to consider the European one of the latest human types. In early times this race was probably slightly specialized in a number of areas, each area exhibiting a considerable degree of variability. The loss of pigmentation, and change in facial form, were not equally pronounced everywhere, so that one region would be darker colored or broader faced than another, although not by any means uniform in itself. For this reason the occurrence of blondes or of narrow-faced and elongated heads in an otherwise dark, broad-faced and short-haired region does not necessarily prove mixture. At present we have no means of telling how stable these types had become before the extensive mixture which certainly has taken place throughout Europe. For this reason it seems a vain endeavor to seek for individuals representing the 'pure type,' even if there had been no mixture. In his discussion of the 'Three European Races' (Chap. VI.) Professor Ripley acknowledges the variability without, however, discovering that it makes conclusions as to mixture exceedingly doubtful, except in very pronounced cases.

It does not seem to me justifiable to consider all the individuals that are short-headed and brunette, although living in an area which, on the average, is long-headed and blonde, as belonging to the Alpine type, and to explain their presence as due to mixture between the two types. They may simply represent the remoter variations from the long-headed blonde type. This question has a most important bearing upon the explanation of facts of social selection (pp. 537 ff) by the assumption of different tendencies in the two types.

The problem can hardly be solved satisfac-

torily until we have acquired a much better knowledge than we now possess of the variabilities of the various types and of the degrees of correlation between the various features that characterize each type. This information is not yet available. No method has yet been devised for measuring the variability of pigmentation. The military selection, which vitiates so many anthropometric results, unfortunately often obscures the actual variability entirely. Thus all curves of stature in Livi's great work on Italy are asymmetrical on account of the elimination of all individuals below 155 cm. and the decreasing frequency of rejection correlated with increasing stature. This selection increases all the averages, and lessens the variabilities the more, the shorter the average of the type. Neither is it quite safe to take the irregularities of curves of distribution as evidence of mixture, unless they are subjected to a very careful analysis.

The author considers as the most valuable anthropometric characteristic the form of the head as expressed by the cephalic index, and depreciates the value of facial proportions and of absolute measurements. We cannot quite agree with this view. The cephalic index is often a most valuable means of distinguishing the types composing a race, but not by any any means the only one. Our selection of characteristic measurements must always be guided by existing differences, whatever these may be. Two types may have the same cephalic index and still differ in the general form of the skull and of the face to such a degree as to require separate treatment. Neither must we disregard the absolute values of the diamters of the head. The great length of the negro cranium as compared to its small capacity has a meaning quite different from the same length of the European cranium of large capacity. For this reason we cannot accept the daring map of the distribution of the cephalic index the world over (p. 42) as signifying any racial relationships. Cephalic index alone cannot be considered a primary principle of classification.

Neither are cephalic index and pigmentation alone a sufficiently broad basis for the characterization of racial types. The consideration of these two features leads the author to designate the European Race as intermediate between the African and Asiatic Races, without considering the great objections to this theory which are found in the form of the face, the size and form of the brain, the proportions of the extremities. Neither do we feel it safe to explain the fine, wavy hair of the European as due to a mixture between the frizzly African and the straight Asiatic hair.

We most heartily concur with the author's emphatic demand for treating physical, ethnographical, and linguistic methods separately. The misconception of what constitutes a racial type, a cultural group, and a linguistic stock has caused a vast amount of futile speculation. The three methods may be used, each in its particular domain, for reconstructing part of the history of mankind, and each may be used, to a limited extent, as a check on the two others. When two tribes of people speak closely related languages the inference may be drawn that they are in part related in blood, although the strain of common blood may be so slight as to escape anthropometrical methods entirely. Cultural similarity is no proof of blood relationship, since culture may be easily disseminated among tribes of different descent.

We cannot undertake, in this brief review, to discuss in detail the data and theories regarding the history and distribution of types in various parts of Europe. The book contains no tabular statements that would enable the reader to check any of them. It is the intention of the author that the student should verify his statements by the help of the very full bibliography which accompanies the volume. The 'Supplementary Bibliography of the Anthropology and Ethnology of Europe' is very complete in everything pertaining to anthropometry and to the study of pigmentation. The fact that Professor Ripley had to deal entirely with European literature is the cause that he uses the two terms Anthropology and Ethnology as meaning Somatology and Racial Classification, while their American use is quite different, Anthropology denoting the science of man in general, and Ethnology dealing with the activities of man. The supplementary titles bearing upon linguistics and archæology are not intended to be exhaustive, but merely refer to the subjects

treated in the text. The titles are conveniently arranged, and, on the whole, accurate, although the proof-reader might have been more consistent in spelling and more careful in reading the titles of foreign publications. The entire omission in the discussion of anatomical characteristics peculiar to the race as a whole and of the characteristics of the inner organs is, of course, repeated in the Bibliography.

The omission of all detailed and tabular matter have helped to give the book an attractive and popular form, but it has made it impossible to substantiate adequately any of the theories which the author advocates. It is to be feared that this method may mislead the general reader to believe that physical anthropology has accomplished much more than it actually has done, and that it may tend to perpetuate opinions which are likely to be materially altered by further inquiries.

Franz Boas.

QUARRY INDUSTRY AND QUARRY GEOLOGY.

Under this title comes to us from the pen of Dr. O. Herrman, teacher in the Technological Institute at Chemnitz, Saxony, and from the press of Borntraeger Brothers, Berlin, an interesting volume of 428 pages on 'technical geology with practical hints for the commercial use of stone,' having special reference to the quarry industries of the Kingdom of Saxony. The briefest glance over its pages gives rise to the wish that we had as thorough a work on the building stones of our own country, for, in addition to its fullness of information, it possesses that rare quality of careful arrangement which is so seldom found in books. The work opens with a bibliography of the field covered, a list of institutions where building materials may be tested, with a brief tabulation of the modes of testing and a list of the geologic museums and larger study collection of rocks in Saxony.

The scientific discussion opens with a description of the rock-making minerals and their distribution; then follows a careful discussion of the rocks, their texture, composition and geographic distribution; next is discussed the physical and chemical properties of the minerals and rocks and the bearing of these upon the utility of the latter, and finally are considered certain geologic phenomena and their relation to the utilization of stone. Space is then given to the discussion of the most important uses of the more common stones worked in quarries. A chapter on modes of quarrying follows in proper order, concluding with a description of the methods for dressing the quarried stone.

The second section of the book, which is full of geologic and technical detail, is devoted to a discussion of the rocks of the Kingdom of Saxony.

The work closes with an appendix in which are discussed Saxon materials for road building and pavements, statistics of the quarry industries and a very useful tabular statement of the scientific and commercial characters of the different kinds of rock available for constructive purposes.

This work in its systematic arrangement is to the technological student what the classic works of Rosenbusch are to the petrographer. It must be conceded that we owe much to Germany for original research on the structure and classification of rocks and also for careful and accurate discussion of the facts determined. In our own country, unfortunately, at the present time, the knowledge of the architect and engineer on the subject of building stones is somewhat empirical and while accurate, since it is based on actual experience, is not fully collated and recorded in any one book to which one may turn for exhaustive information. It is to be earnestly hoped that the example of Dr. Herrman's publication will influence some one of our many competent authorities to group together and classify for publication all that is known about the building stones of North America.

F. J. H. M.

THE DEPOPULATION OF FRANCE.

There are interesting and important books on various subjects and there are also various books on interesting and important subjects. To the latter class belongs *Natalité et Démocratie*, written by M. Dumont and published at Paris by MM. Schleicher. The statistics are so badly arranged that it is difficult to find definite information, while the discussion does not carry much weight. But the problem is of extreme

importance. Only fifty years ago Malthusianism reigned. But applied science showed that the means of subsistence could be increased far more rapidly than the population. Now, in spite of the lowered death rate, the native population is actually decreasing in France and in New England, and is probably tending in this direction everywhere. The causes are not physiological, but psychological and social. M. Dumont blames the selfishness of democracies; he thinks that they are really aristocracies in which everyone wants to be an aristocrat and live in luxury. But it would probably be just as correct to blame our altruism. Our improved means of production, our improved hygiene, our charities and our sentimentalism have interfered with the struggle for existence, and fertility—physiological or psychological—has no longer a high selective value. It is doubtful whether M. Dumont will accomplish anything by preaching the patriotism and morality of large families. M. Bertillon's recent suggestion that an inheritance tax be imposed inversely proportional to the number of children is more reasonable, but it would only give a slight and temporary alleviation. The State would be more likely to succeed by the encouragement of early marriages, especially in the case of children from large families. But the whole problem is extremely difficult.

J. MCKEEN CATTELL.

GENERAL.

W. SCHMIDT'S *Heron von Alexandria* (B. G. Teubner; 15 pp., 3 plates; .80 M.) is a review of the first volume of a new edition of Heron's works. The article contains 39 figures (partly conjectural) illustrating the many curious and ingenious automata designed by Heron for public amusement in gardens and theaters. The article gives a good idea of the subject and is interesting to the philologian as well as to the mechanic and physicist.

NUMBER VI. of the Studies from the Yale Psychological Laboratory has just been issued. It contains: 'A color-illusion' (with colored plate), by Professor G. T. Ladd; 'Researches in cross-education,' by Professor W. W. Davis, and 'Researches in practice and habit,' by Dr. W. Smythe Johnson. A number of copies has been set aside for gratuitous distribution to persons who may be interested; a copy can be obtained by application to Dr. E. W. Scripture, New Haven, Conn.

BOOKS RECEIVED.

Proceedings of the U. S. National Museum. Published under the Direction of the Smithsonian Institution. Washington, Government Printing Office. 1899. Vol. xxi. Pp. xiii + 933.

Analyses électrolytiques. AD. MINET. Paris, Gauthier-Villars. 1899. Pp. 176.

Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1897, under the Direction of N. A. F. Moos. Bombay, Government Central Press. 1898. Pp. xviii + 12 tables. Price, 2s. 6d.

SCIENTIFIC JOURNALS AND ARTICLES.

Appletons' Popular Science Monthly for September opens with an article on the plague by Professor C. V. Vaughan, of the University of Michigan. In discussing recent legislation against the drink evil, Dr. Appleton Morgan argues that high licenses, damage laws and laws against adulteration are a sufficient remedy. Among the other articles is one on the milk supply of cities by Professor H. W. Conn; on the influence of the weather on crime by Dr. Edwin G. Dexter; on the survival of African music in America by Mrs. Jeanette R. Murphy, and a sketch of the zoologist Oscar Schmidt with a portrait as frontispiece.

DR. L. V. PIRSSON, professor of physical geography in Yale University, succeeds the late Professor O. C. Marsh on the editorial board of the *American Journal of Science.*

THE *Atlantic Monthly*, 'devoted to literature, science, art and politics,' but not in equal measure, has again changed editors. Mr. Walter H. Page has accepted a position in a New York publishing house and is succeeded by Professor Bliss Perry, of Princeton University.

DISCUSSION AND CORRESPONDENCE.

SCHEDULE FOR PSYCHOLOGY OF THE INTERNATIONAL CATALOGUE.

TO THE EDITOR OF SCIENCE: Professor Cattell is right in saying (SCIENCE, Aug. 11) that no scheme of classification for psychology

has been circulated with the other schemes by the Royal Society; but one has been prepared. The present writer was asked by Professor Michael Foster to cooperate with Mr. Stout, the editor of *Mind*, who has been selected as the British representative of psychology. Mr. Stout prepared a detailed classification, which was extensively revised by my colleague, Professor Warren (the compiler of *The Psychological Index*) and myself. Our suggestions were all accepted by Mr. Stout and the schedule has been printed, a single copy reaching me some weeks ago. I know no reason for the failure of the committee to circulate it.

J. Mark Baldwin.

Princeton, August 16th.

The schedule for psychology was not presented to the Committee of Columbia University requested to report upon the plans. Neither, as I am informed, has it subsequently been sent to the responsible editor of Science, to the editor at present responsible for the *Psychological Review* and *Index* or to the professor of psychology of Columbia University. The proceedings of the Conferences on an International Catalogue of Scientific Literature appear to have been held in secret and concealed long thereafter. Science is, so far as I am aware, the only journal in the world that has given an adequate account of the conferences or extended reviews and criticisms of the plans. There is doubtless some reason for the methods of the Royal Society, but if the catalogue is to be begun with international assistance at the beginning of next year it is time that the explanation should be forthcoming.

J. McKeen Cattell.

POT-HOLE VS. REMOLINO.

To the Editor of Science: If more room can be spared for the discussion of so inconsequential a matter, may I say that a sufficient argument against the adoption of the word 'Remolino' lies in the fact that it is not needed. The term 'Pot-hole' is with us, and, whatever its origin, its meaning is plain. There is no more cause for substituting a Spanish word here than for the substitution of the Spanish language for the English as a whole. One can but be reminded of the ridiculous attempts at substituting French names for good old American and English dishes on the bills of fare in many of our restaurants and hotels.

George P. Merrill,
Department of Geology, U. S. Nat. Museum.

NOTES ON PHYSICS.

THE TRANSMISSION OF LIGHT THROUGH ABSORBING MEDIA.

Professor Oliver Lodge, in his presidential address before the London Physical Society,* gives a historical sketch of the theory of the passage of light through absorbing media (opacity), the subject being brought down to date; in fact, Professor Lodge discusses some of Heaviside's results which are as yet unpublished. Those who are interested in the subject will find the address most interesting and instructive; it cannot, of course, be abstracted

W. Voigt, in Wied. Ann. 1899, No. 7, gives a general solution of the equation of wave propagation in an absorbing medium. This solution is identical in form to the solution of the 'telegraph equation,' so-called, which expresses the attenuation and variation of form of a telegraph signal. Voigt refers to Poincaré and Picard as having discussed this subject of telegraph signalling and of light transmission through absorbing media.

Readers of English cannot hold Voigt, Poincaré and Picard seriously responsible for their ignorance of the fact that this whole subject of light transmission through absorbing media and of telegraph signals has been very completely worked out by Heaviside, for probably a very few English readers are familiar with his remarkable work. Professor Lodge's presidential address, mentioned above, is almost wholly devoted to the discussion of Heaviside's work, apparently because of its preponderating importance and exceeding simplicity.

Lodge gives, in his address, the steps in the solution of the equation of wave propagation in an absorbing medium (Heaviside, 1887), which, compared with Voigt's solution, is simplicity itself.

* Proceedings of Phys. Soc., XVI., pp. 351–386.

SPREADING AND REVERSAL OF SPECTRAL LINES.

WANNER, Wied. Ann. 68, p. 143, 1899, describes the change of the sodium spectrum when the light from the flame is repeatedly reflected back and forth through the flame. He finds a spreading of the D lines, accompanied by a sharply defined reversal, and a weak continuous spectrum in their neighborhood.

W. Voigt, Wied. Ann. 68, p. 604, shows that this observation of Wanner is in qualitative accord with his theory of the emission of a layer of gas, which theory shows that in the radiation from a thin layer the wave-length which would be most absorbed would be of maximum intensity; while the radiation from a very thick layer would give a continuous spectrum with a dark absorption line; that is, a reversal of the original spectral line.

LECTURE EXPERIMENTS WITH THE WEHNELT INTERRUPTER.

E. LECHER, Wied. Ann. 68, p. 623, 1899, describes some very beautiful experiments showing the action of a magnetic field upon the electric discharge from an induction coil using a Wehnelt interrupter. The experiments illustrate the well-known sidewise movement of the spark (arc) across the magnetic field. The high frequency obtained with the Wehnelt interrupter, together with the fact that the discharge approaches the character of an arc, makes the effect of the magnetic field most striking in appearance; and the author describes several arrangements of the apparatus well suited to lecture-room demonstration.

VELOCITY OF ELECTRIC WAVES IN AIR.

MR. G. V. MACLEAN describes, in *Phil. Mag.*, July, 1899, a very successful application of the coherer in the location of the modes and antinodes of a stationary electric wave train reflected from a metal sheet. Mr. MacLean's object was to determine the velocity of the waves from the observed wave-length and the periodic time of the oscillator.

The coherers used consisted essentially of two platinum globules which were adjusted to delicate contact, and a milliamperemeter in circuit with the coherer and a battery gave the indications. The coherer gave no response at all at the nodes, and the readings over more than a whole wave of the stationary train were remarkably regular considering the erratic space action of the ordinary form of the coherer.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

THE great problem in obtaining argon from the atmosphere is to remove the nitrogen. In the earlier experiments, as in that of Cavendish, the electric discharge was passed through air confined over potash, whereby the nitrogen is gradually oxidized and absorbed. Later it was found that nitrogen was absorbed directly by various metals with different degrees of rapidity. Magnesium was first used by Ramsay, and somewhat later Ouvrard used lithium, while more recently Maquenne's mixture of magnesium with lime has been found practically most efficient. A very thorough study of the different absorbents has been made by Hempel, in the *Zeitschrift für anorganische Chemie.* He finds that lithium is five times as efficient as magnesium, the magnesium-lime mixture eight times, while if to a mixture of one part magnesium dust with five parts lime a quarter part of sodium is added, this absorbent is no less than twenty times as rapid in its action as magnesium alone.

THE early experiments of Professor Berthelot on the absorption of argon by organic compounds under the prolonged action of the silent discharge have now been very largely extended, and are described in the *Comptes Rendus.* With quite a large number of compounds of the fatty series, such as ethylene, aldehyde, acetone, propionitril, the result was negative. On the other hand, with benzene, turpentine, phenol, benzaldehyde, benzonitril and quite a number of other compounds of the benzene series from one to six per cent. of argon was absorbed, and at the same time there was a fluorescence of greenish color and with a characteristic spectrum.

IN the same number of the *Comptes Rendus* there is an interesting observation by M. Chesnan to the effect that chromous salts, like ferrous, have the property of absorbing nitric oxid. The compound formed, however, is

much more stable than the ferrous, for it does not give off the gas on heating nor in a vacuum.

The experiments of Weinland and Lauenstein have shown that in the alkali iodates an atom of oxygen can be replaced by two atoms of fluorin. Further researches on these fluorin salts have been carried out by Weinland and Alfa and are described in the *Zeitschrift für anorganische Chemie.* Quite a series of fluophosphates, fluo-sulfates, fluo-selenates, fluotellurates and fluo-dithionates have been formed. In all of these the fluorin does not directly replace the oxygen, but the P=O, S=O, etc., groups appear to be converted into $P<^{OH}_{F}$, $S<^{OH}_{F}$, etc. Most of these compounds crystallize well and their crystallographic characteristics are described by H. Zirngiebl.

In the *Zeitschrift für angewandte Chemie* the subject of a substitute for gasoline and benzine for many technical purposes is discussed by A. Ganswindt. The great danger from fire and explosion, ignition being caused even by the electric spark, is well known. The use of various chlorinated hydrocarbons is suggested, as carbon tetra-chlorid, which is, indeed, already used to some extent in this country. It is also possible that some of the chlorination products of acetylene may prove of real value along this line.

J. L. H.

RETURN OF THE WELLMANN EXPEDITION.

Reuter's Agency announces that the steamship *Capella* arrived at Tromsö on August 18th from Franz Josef Land. The vessel brought with her Mr. Wellmann's expedition, with which she fell in at Cape Tegetheff. It is reported that the expedition reached the 82d parallel of north latitude. The party bring with them the following remarkable story: In the autumn of 1898 an outpost called Fort McKinley was established in latitude 81, and a house was built of rocks and roofed over with walrus hides. During the voyage of the *Fram* two Norwegians named Paul Bjoervig and Bernt Bentzen remained there. The main party wintered in a canvas-covered hut at Cape Tegethoff, in latitude 80. In the middle of February, before the rise of the sun and in the depth of winter, Mr. Wellmann, with three Norwegians and 45 dogs, started north, this being the earliest sledge journey on record in such a high altitude. On reaching Fort McKinley they found the two men who had been with Nansen. Bentzen had died, and Bjoervig, in accordance with a promise he had made, kept his companion's body in the house, sleeping beside it through two months of Arctic darkness.

Pushing northward through rough ice, with severe storms and, for ten days, a continuous temperature of 40 to 50 degrees below zero, the party discovered men in lands north of the Freeden Islands, where Nansen landed in 1895. In the middle of March, when all hands were confident of reaching latitude 87 or 88, if not the pole itself, Mr. Wellmann, while leading the party, fell into a snow-covered crevasse, seriously injuring his leg, and the party, was therefore, compelled to retreat. Two days later they were roused at midnight by an earthquake, and in a few moments many dogs were crushed and sledges destroyed. The men narrowly escaped with their lives, saving their precious sleeping bags and some dogs and provisions. Mr. Wellmann's condition became alarming on account of inflammation, but his companions dragged him on a sledge, making forced marches for nearly 200 miles to the headquarters of the expedition, where they arrived early in April. Mr. Wellmann was still unable to walk, and he is probably permanently crippled. In subsequent sledge journeys the expedition explored unknown regions, and important scientific work was done by Dr. Hofna, Lieutenant Baldwin, and Mr. Hanlan. The expedition killed 103 walruses and eight bears. No trace of the Andrée expedition was found. The *Capella* picked up the expedition on July 27th and sailed homeward on August 10th. On the 6th inst. the *Stella Polare*, with the party of explorers headed by the Duke of the Abruzzi on board, was sighted in Broejenz Sound, 80° 20′ north latitude. All were well on board.

SCIENTIFIC NOTES AND NEWS.

We are able to publish as a frontispiece to this issue a portrait of Dr. Edward Orton, President of the American Association for the Advancement of Science, through the courtesy of

Messrs. Munn & Co., publishers of the *Scientific American*.

As is stated elsewhere in this number, Mr. Emerson McMillin, of New York, has generously given $1,000 to the research fund of the American Association. This is especially welcome, as it is now many years since Mrs. Esther Herrman, the only surviving patron, made a similar gift. Mr. McMillin originally sent President Orton $500 to be used by the local committee if needed, and if not to be turned over to the Association. Though in view of their liberal arrangements and entertainments, the expenses of the local committee must have been large, they preferred to pass on the fund to the Association. When Mr. McMillin, who as a member of the Association was present at Columbus, learned that an increase in the research fund was greatly needed he doubled his original gift.

THE British and French Associations for the Advancement of Science will not only interchange visits at the approaching Dover and Boulogne meetings, but there has also been arranged a five days' excursion of members of the British Association through France.

THE British Parliament has sanctioned a grant of £12,000 for a National Physical Laboratory, with an annual appropriation of £4,000, and Mr. R. T. Glazebrook, now Principal of University College, Liverpool, has been appointed director. The establishment of the laboratory is due to action on the part of the British Association.

WE understand that the Boston Public Library will undertake the publication of a card catalogue of physiology, the cards to contain not only the ordinary bibliographical information, but also brief abstracts of the papers. The plan originated in the physiological department of the Harvard Medical School, and Professor W. T. Porter will be responsible for securing or preparing the abstracts.

A NEW regulation on Russian weights and measures was published on August 18th. The current standards are defined in terms of the metric system. The metric system is to be optional, and may be used on a par with the Russian in commerce, in dealing with contracts, accounts, etc., and after mutual agreement by State and municipal authorities. Private persons are, however, to be under no compulsion to use the metric system when dealing with the above-named authorities.

AN International Congress of Physics will be held in connection with the Paris Exposition from the 6th to the 12th of August, 1900. No International Congress of General Physics has yet been held, the present Congress being due to the initiative of the French Society of Physics. The Committee of Organization, of which M. Cornu is President, suggests the following program: (1) reports and discussions on a limited number of subjects arranged in advance, such as 'The definition of units,' 'The bibliography of physics' and 'National laboratories'; (2) visits to the Exposition, laboratories and workshops, and (3) conferences on recent advances. The secretaries of the committee on organization will be glad to receive suggestions in regard to the work of the Congress and will send future programs to those interested. The Secretaries are Ch. Ed. Guillaume, au Pavilon de Breteuil, Sèvres (Seine-et-Oise) and Lucien Poincaré, 105 bis, boulevard Raspail, Paris.

IT is expected that the new lecture hall of the American Musuem of Natural History, with a seating capacity of 1,700, will be ready about November 1st. The exterior of the new east and west wings is also practically completed, but progress on the interior is stopped by complications in city politics through which the payment of appropriations is delayed.

AMBASSADOR WHITE, now at Berlin, General A. W. Greely, Chief of the Signal Service, and Professor Willis L. Moore, Chief of the Weather Bureau, have been appointed delegates from the United States to the International Geographical Congress, meeting in Berlin from September 28th to October 4th.

THE council of the Royal Botanic Society have appointed Mr. James Louis North Curator of the Society's Museum at Regent's Park.

SIGNOR MARCONI, it is said in the daily papers, will visit the United States next month with a view to introducing his methods of wireless telegraphy.

THE Upper Italian Council of Health has awarded a fund to Professor Grassi to aid him in continuing his investigations on malaria.

IN the last report of the Potsdam astrophysical observatory it is stated that the position of assistant, vacant by the removal of Miss Alice Everett to Vassar College, has been filled by the appointment of Dr. Ludendorf, of the Hamburg observatory. Dr. Eberhard has also been appointed an assistant in the place of Dr. Clemens, who has removed to the Bamberg observatory. Professors Wilsig and Scheiner have been promoted to be observers.

DR. L. A. BAUER will leave Washington for Europe early in September, on business for the Coast and Geodetic Survey, and is to be away about three months. He will inspect various magnetic observatories, and compare the Coast and Geodetic Survey instruments with observatory standards. He will also attend the Seventh International Geographical Congress, to be held in Berlin, as delegate from the National Geographic Society of Washington.

MESSRS. J. A. FLEMING and H. W. Vehrenkamp, who graduated this year at the University of Cincinnati, having successfully passed the civil service examination for Aid in the Coast and Geodetic Survey, have been assigned to the Division of Terrestrial Magnetism.

THE death is announced of Alph. de Marbaix, professor of zoology and anatomy in the Agricultural Institute at Loewen.

WE regret also to record the death of Dr. N. Grote, professor of psychology and philosophy at the University of Moscow and editor of the only Russian journal devoted to these subjects.

DR. J. B. HATCHER, of the department of zoology and paleontology of Princeton University, has returned from his expedition to Patagonia. We hope to be able to publish shortly an account of the important scientific work accomplished.

THROUGH a chance meeting with a fishing boat a letter has been received from the steamship *Diana* dated July 24th and stating that all were well and that they were expecting to reach Disco and meet Lieutenant Peary on July 30th.

MR. S. E. CASSINO, Boston, announces that he will publish during the present year a new edition of the *Naturalists' Directory*.

THE Iron and Steel Institute of Great Britain met at Manchester, beginning on August 16th, Sir William Roberts-Austen occupying the chair.

THE American Pharmaceutical Association will meet on September 4th, and the following days at Put-in Bay, Ohio.

THE fifth meeting of the French Congress of Medicine opened at Lille on July 28th under the presidency of Professor Grasset, of Montpellier, who delivered an address on medical progress in France in the nineteenth century.

THE 12th International Congress of Orientalists will be held this year from October 3d to October 15th, at Rome, under the patronage of the King of Italy. The meetings of the Congress will be held in the buildings of the University of Rome, but the inaugural and closing ceremonies will take place in the Capitol. Members, who may secure tickets from the Treasurer of the University of Rome, can obtain a reduction of fifty per cent. while traveling through France and Italy.

As we have already stated, an International Commercial congress will be held in connection with the Philadelphia Commercial Exposition. It will open on about October 10th, and will include delegates from at least thirty-one foreign governments and 126 foreign chambers of commerce and similar bodies. Many of the topics proposed for discussion are of direct or indirect interest to men of science.

THE plague has been so long prevalent in India that it has ceased to attract a considerable share of public attention. The occurrence of cases in Mauritius and Oporto and the suspicion of their presence in Naples and in other cities should, however, not be disregarded. The death of Dr. Müller at Vienna shows that the disease may be highly contagious in spite of the most careful scientific precautions. An epidemic, such as the 'black death' of earlier centuries may be very improbable, but it cannot be regarded as entirely impossible.

A REUTER'S telegram announces that the expedition of the Liverpool School of Tropical Diseases, under the direction of Major Ronald Ross, I. M. S., has arrived safely at Freetown, Sierra Leone, all well. Major Nathan, the Acting Governor of the Colony, has written to

Mr. Alfred L. Jones, the Chairman of the School, stating that he will do all he can to assist the expedition, and expressing the hope that one result will be the establishment of a bacteriological laboratory in the colony.

THE American word 'scientist' proposed by the late Dr. B. A. Gould is apparently becoming acclimatized in Great Britain. Though *Nature* has stated that the word is excluded from its columns it has occurred in the editorial notes. It will also be found in the *Academy* and in the London *Times*. The latter in the issue of August 15th even uses the word retroactively speaking of 'the great German scientists of the past.' But the best testimony that the word must now be regarded as correct and classical English is the fact that it is to be found in Mr. Thomas Hardy's 'Two on a Tower.'

THE issue of *Nature* for August 10th says: "We have received the number for July 21st of our American contemporary SCIENCE, which contains an elaborate article by Professor Underwood, headed 'The Royal Botanic Gardens at Kew,' in which the features of the garden and its position as a scientific institution—'its beautiful lawns, its delightful shade, its historic associations, its immense collections of plants, and its wonderful activity in the direction of botanical research'—are described and discussed with critical appreciation *apropos* the recent establishment of the Botanic Garden of New York and its capability to become 'even more influential in democratic America than Kew has become throughout the length and breadth of the Queen's dominions.' It is gratifying to have this acknowledgment of the work of Kew; and the tribute paid to the versatility and ability of Sir William Thiselton-Dyer in promoting its devolopment and widening its influence will be everywhere endorsed. There are some blots on the escutcheon in the eyes of Professor Underwood, but we imagine there are many who will not see with him in all the instances he mentions. The crowding of the museum collections he notes is an apparent blemish, and one we may hope to see removed by the provision of increased room for the exhibition of the specimens. A somewhat jealous comparison of Kew and Berlin as centers of botanical work is a jarring note in the article; and Professor Underwood allows, we fear, German bias to weigh with him in making it, for instance, when he writes, 'the principles of plant distribution are not so thoroughly grasped at Kew as they have been brought out at the German Botanical Garden through the skill of Professor Engler and his associates.' Yet Kew is the home of Sir Joseph Hooker!"

WE learn from the London *Times* that the last issue of the Proceedings of the Asiatic Society of Bengal contains a paper by Mr. Oldham, the Superintendent of the Geological Survey of India, on the present system in that country by which every place keeps its own time. Mr. Oldham describes this as a barbarous arrangement, unworthy of a country pretending to civilization. A traveler going from one town to keep an appointment in another must find out how many minutes there is between the times of the two. To some extent a standard time is used, for the railways adopt Madras mean time all over India, and the telegraph department does the same, but the Official Telegraph Guide contains a table of 44 pages giving the difference between local and standard times. The adoption of a single standard time for India would cause inconvenience because of the extent of the empire from east to west; in some places the difference would exceed an hour. This difficulty, Mr. Oldham suggests, would be met by adopting the system in use in Europe and North America of hour zones, by which the region is divided into belts running north and south, each 15° of longitude in width. Over each belt the same time is used, while in belts to the east and west a change of an hour forwards or backwards is made. In India the lines could follow the boundaries of the chief administrative divisions, as is done in the United States, Canada and Russia. After discussing various suggested standards of time, Mr. Oldham recommends the adoption of the hour-zone system, using Greenwich as the starting point. This would give only two different times in India, an eastern time, exactly six hours later than Greenwich time, in use in Bengal, Assam and Burma, and a Western time, exactly five hours later than Greenwich, in use in the rest of India.

The traveller in either group of presidencies or provinces would find the same time in use everywhere, and when he crossed the boundary he would know that the time was an even hour earlier or later according as he was travelling westward or eastward. In practice, in Calcutta all watches would have to be put back six minutes, but, on the other hand, the railway clocks and those in the rest of the town would not show different times. "I have myself," says Mr. Oldham, "recently had to deal with a mass of time records referring to the earthquake of 1897, and found that a large number had to be rejected because it was impossible to ascertain what standard of time had been used, while in many others it was only after a large mass of calculations had been gone through that the relation of observations from different places to each other could be determined." The steps necessary to initiate the changes are stated to be very simple. The first would be to discontinue the 44 pages of variations in the Telegraph Guide, and when local time was no longer obtainable at the telegraph offices standard time would soon come into general use. In the local observatories in the presidency towns the time signals should be converted into Greenwich time; and in all public offices standard time should be used. "If this were done, the experience of other countries has shown that the general public would soon come to adopt the standard time, and having once appreciated its advantages would soon wonder how they had so long endured the old system."

UNIVERSITY AND EDUCATIONAL NEWS.

It is reported that plans are being made for the establishment of a university at Ottawa.

McGill University proposes to erect at the cost of $70,000 a building for its departments of hygiene, pharmacology and medical jurisprudence. In the medical department of this university Dr. T. J. W. Burgess has been appointed professor of mental diseases.

The will of the late Dr. C. J. Stillé, formerly Provost of the University of Pennsylvania, leaves the income of his property to his wife, but on her death the property will be divided equally among Yale University, the Historical Society of Pennsylvania and a Philadelphia Church. The estate is valued at $150,000. The money given to Yale is to be used for undergraduate instruction in history and political science.

Glasgow University has received £10,000 by the will of the late James Brown Thomson, who has bequeathed £80,000 to the educational and benevolent institutions of Glasgow.

In the July intermediate examination of the University of London, for the first time in its history, the number of candidates in science was greater than in arts. It is said that this change in the relative numbers of candidates in the two faculties is attributed to the fact that the demand for science teachers in colleges and schools is now greater than the demand for teachers of classics and mathematics, and that the remuneration of the former is better than that of the latter.

An International Congress of Higher Education will be held at Paris from the 30th of July to the 4th of August, 1900. The committee of organization has decided that the following topics shall be discussed in the general sessions: (1) University extension; (2) measures for the benefit of students; (3) the education of teachers; (4) the place of the university in agricultural, industrial and commercial education; (5) the international relations of universities and their professors; (6) relations between the faculties of laws and of arts. Special sections will be formed for the discussion of: (1) Law, (2) political and social sciences; (3) geography; (4) history and philology; (5) philosophy and related sciences. Tickets of membership cost only 10 francs and may be obtained from M. Larnande at the Sorbonne, Paris.

The Russian authorities seem bent on spreading disaffection among the people. For quite trivial offences the students at the universities and technical schools were imprisoned, and after they had become thoroughly disaffected were dispersed to their homes throughout the country. Now it is announced that students will be punished by compulsory service in the army for from one to three years, which will naturally spread in the most dangerous quarters any revolutionary views they may have formed.